Regulations, Scheme, Curriculum & Syllabi

Five Year Integrated
Master of Science Programme

(2020-21 Academic year onwards)

Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)

Mahatma Gandhi University

Kottayam-686560

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Institute for Integrated Programmes and Research in Basic Sciences (IIRBS) MahatmaGandhiUniversity, Kottayam	
Programme	**Five Year Integrated Master of Science (Integrated M.Sc.)**

Preamble:

A knowledge centre comprising of Sophisticated Instrumentation Facility, instructor-led classroom teaching and technology–enhanced learning techniques, first of this kind among the universities in Kerala, namely Institute for Integrated Programmes and Research in Basic Sciences (IIRBS), has been instituted directly under Mahatma Gandhi University in 2008. The Institute aimed to provide intellectual, instrumental as well as experimental support for pursuing excellence in basic science branches and is expected to contribute to the talent pool of researchers and specialized technicians. Subsequently, the Institute launched a Five year Integrated Interdisciplinary Master of Science (Chemistry, Physics and Biology) programme in the year 2009 for the students who completed their plus 2 with sciences and mathematics.

Now, Mahatma Gandhi University is starting innovative Five Year integrated interdisciplinary Master of Science programmes in five disciplines in the academic year 2020-21, at Institute for Integrated Programmes and Research in Basic Sciences (IIRBS). This unique programme structure offers courses in basic science subjects (Physics, Chemistry and Life Sciences) along with Computer Science and Environmental Science. The curriculum is designed and framed in accordance with the CSS regulations of the University. However, due to the unique interdisciplinary nature of the programme, certain separate rules and regulations are applicable for these Integrated Master of Science Programmes. **Therefore, the CSS rules and regulations of the University shall be applicable for those instances which are not mentioned in these regulations.**

RULES & REGULATIONS

1. **Name of the Programme:** Integrated Master of Science in appropriate disciplines. It shall be abbreviated as Integrated M.Sc.
2. **Offered Disciplines:**
   a) Chemistry (CH)
   b) Physics (PH)
   c) Life Sciences (LS)
   d) Computer Science(CS)
   e) Environmental Science(ES)
3. **Duration:**The duration of the Integrated M.Sc. programme shall be 5 years (10 Semesters). At the end of the programme a student shall be awarded the Integrated M.Sc. Degree in the discipline concerned.
4. **Annual Student Intake:** 20 students (4 each for five disciplines)
5. **Training levels :** There are mainly two levels of trainings,
   - **Foundation Level courses**: All 20 students shall be trained in the first six semesters for the foundation level courses which shall be equivalent to the B.Sc. level programmes in their major disciplines.
   - **Advanced level courses**: 4 students each from five disciplines shall be trained in the final four semesters for the advanced level courses which shall be equivalent to the M.Sc. level programmes in their major disciplines
6. **Eligibility for Application:** Students who have passed Plus-Two (+2) in Science stream with minimum 60% marks or equivalent grade are eligible for application. Relaxation in minimum marks for reservation categories shall be applicable as per the existing rules and orders issued by the university.

7. **Mode of Selection:** The admission to the programme shall be based on a national level common screening entrance test conducted by the university followed by an Interview. A rank list shall be prepared by giving weightage for the marks obtained for entrance examination and Interview in the 80:20 ratio, respectively. Allotment to various disciplines shall be based on the priority of the students in the rank list. Reservations and other admission procedure shall be followed as per University rules and orders.

8. **Monitoring of the Programme:** Academic activities of the Integrated programme shall be monitored and evaluated by an Institute Programme Advisory Committee (IPAC) which will be constituted by the Vice-Chancellor by including the faculty members of the University and other institutions (if required). The Honorary Director of the Institute shall acts as the convener of the IPAC. The IPAC shall also function as the faculty council of the Institute and pass board for finalizing the grades of the students in every semester.

9. **Programme Over view:**
   - This programme follows 3+2 year pattern with initial six semesters of graduate (B.Sc.)level or Foundation level courses followed by four semesters of Post graduate (M.Sc.) level or Advanced level courses.
   - At admission time, students shall be allotted to any one of the five '*Major*' disciplines offered based on their merit and option.
   - However, students shall be allowed to change their major discipline after completion of the first and second semesters, subject to the recommendation from IPAC and approved by the Vice-Chancellor. In such situations, the maximum number of students allotted to a particular discipline (CH/PH/LS/CS/ES) shall not exceed Ten (10) per batch. Such allotment to a discipline shall be based on the merit of the students, assessed through the combined results of the first and second semester examinations declared in the form of Cumulative Grade Point Average (CGPA) at the end of the first year.

10. **Course structure and highlights**:
   - A 'major' course means a course from the discipline in which a student gets admission.
   - The curricula for first semester are completely common for all disciplines and all courses are mandatory.
   - Second to fourth semesters consists of common/optional courses from the offering disciplines as well as general courses.
   - Mathematics courses are spread across initial four semesters and is mandatory for all in the first semester .
   - Manadatory English language courses form part of first and second semesters, while second language courses (either Malayalam, Hindi, Sanskrit, Arabic or French) are included in the third and fourth semesters.
   - Option to choose an open course from integrated M.A. programme is provided in third semester.
   - Fourth semester also consist of core and elective courses from the major discipline.
   - Fifth and sixth semesters exclusively consist of core and elective courses from the opted discipline with a minor research project at end of the sixth semester.
   - Seventh to tenth semester consist of advanced level courses in the major dsicpline
   - Final (10^{th}) semester is completely set aside for a major research project and followed by Viva-Voce.
   - The major research project shall be done under the guidance of a supervising teahcer at IIRBS/statutory teaching schools of the university or under the guidance of an external supervisor at any national/international institutions of repute approved by the IPAC.
   - Open course in the $nine^{th}$ semster shall be opted from any other teaching schools of the campus.
   - Students shall be allowed to choose elective courses from SWAYAM or similar; instead of the offered electives or as an add on course.
   - There shall be flexibility for Board of Studies/Expert Committee/IPAC for updating the content of course(s) and to include new open courses and elective courses depending upon the advancement

of knowledge in various disciplines. However this has to be got approved by the Vice-Chancellor before the commencement of the semester involving the course.

11. **Credits:** The total credit for Integrated M.Sc. programme shall be **200** for 10 semesters in which **120** credits for Foundation level (first six semesters) and **80** credits for Advanced level (last four semesters) courses. These credits shall be spread across core courses, electives, open courses, seminars and minor/major project/dissertation. However there shall be flexibility in the requirement of minimum/maximum credits for core and elective courses per semester as well as for whole programme.

12. **Course code:** Each course shall have a unique coding pattern with four abbreviated components including the following;
    - Programme code (IMS)
    - Course type (C-for core, E-for elective, O-for open course),
    - Three digit course number in Arabic numerals in which fitst digit reperesents the semester number except 10^{th} semester for which first two digits designates the semester number.
    - Course description abbreviated with two English capital letters [CH=Chemistry, PH=Physics, LS=Life Sciences, CS=Computer Science, ES=Environmental Sceince, MM=Mathematics, GE=General course, XL= for language courses (where 'X' denotes the first letter of the language concerned; e.g. EL for english), SM=Seminar, VV=Viva-voce, PR= Project, PV=Project and Viva-voce etc]. For elective courses; one more arabic numerals n (n=1,2,3..etc) will be followed after the course description letters, based on the elective(s) chosen.

    However, Open Courses (in semster III and IX) shall have a different coding pattern depending upon the Programme/Schools offering that open course.

13. **Award of Degrees:** After successful completion of 10 semesters; B.Sc. and Integrated M.Sc. degrees in the major discipline shall be awarded separately. First three years (Foundation Level) courses will be considered for awarding Bachelor's degree based on the major opted in IV to VI semesters with completion of minimum course credit of **120** and **minimum graduating CGPA of 5**. Fourth and fifth years (Advanced Level) courses will be considered for awarding the Master's degree in the major discipline with completion of minimum course credits of **80 and minimum graduating CGPA of 4**. Successful completion of the Major Project and Viva-voce is mandatory requirement for the award of Integrated M.Sc. degree.

14. **Faculty:** The degree(s) of the programme(s) shall be awarded under the **Faculty of Sciences** except for Environmental Sciences discipline, in which the degree shall be awarded under the **Faculty of Environmental and Atmospheric Sciences**.

15. **Evaluation:** The evaluation of the courses shall be done on the basis of continuous internal assessment and end semester examinations. However, lab courses shall be evaluated based on continuous internal assessment only.

16. **Grading system:** The grading system shall be as stipulated by CSS regulations of the university.

17. **CGPA and SGPA:** The computation of SGPA and CGPA shall be as stipulated by CSS regulations.

18. **Exit option:** Exit option (after UG level courses) is normally not allowed. However students are eligible to get their Under Graduate level degree certificates, after successful completion of six semesters of the programme. This provision shall be availed by students only under special circumstances as convinced by the Institute Programme Advisory Committee and approved by the Vice-Chancellor

19. **Re-admission, Condonation and Internal Re-do:** As per University rules and orders.

20. **Reappearance and improvement examination:**
    a) For the foundation (UG) level courses, students in the 1^{st} to 6^{th} semesters who have secured the minimum letter grade of 'C' or 'P' in the end semester examination can improve their grade by reappearing for all the courses of that semester together with the next immediate batch

provided the student has paid the required fee. In such cases the the student will be awarded a new grade only if there is an improvement, otherwise the student is eligible to retain the (previous) grade.

b) Students in the 1st to 6th semesters who have secured a letter grade of 'F' or 'Ab' in any of the course(s) can avail two immediate consecutive chances to reappear the examination course wise, provide the student has applied for the same and paid the required fee.

c) The improvement and reappearance of courses during the 7th to 10th semesters, shall be done based on the CSS regulations of the university. In such cases the 7th to 10th semesters of integrated programmes shall be treated similar to 1st to 4th semesters of conventional PG programmes.

d) In any case may be; the course requirements for the Foundation (UG) level courses must be completed within 9th semester of the programme and the course requirements for the Advanced (PG) level courses must be completed within a maximum of fourteen semesters.

21. **Re-do the project work at the VIth and Xth semesters**: The Project work has to be successfully completed during the stipulated time of the programme. If a student fails to do so on genuine reasons, student shall be allowed to re-do the project work (within the next two years) with the sanction of the Vice-Chancellor.

22. **Fee structure**: The Fees structure for the integrated programme is given below. This shall be revised from time to time based on the rules and orders of the university. In addition to this, examination fees have to be paid in every semester as per University rules and orders.

<table>
<tr><th rowspan="2"></th><th rowspan="2">Item</th><th colspan="10">Semester</th></tr>
<tr><th>1st</th><th>2nd</th><th>3rd</th><th>4th</th><th>5th</th><th>6th</th><th>7th</th><th>8th</th><th>9th</th><th>10th</th></tr>
<tr><td>1.</td><td>Tuition Fee</td><td>3200</td><td>3200</td><td>3200</td><td>3200</td><td>3200</td><td>3200</td><td>4600</td><td>4600</td><td>4600</td><td>4600</td></tr>
<tr><td>2.</td><td>Admission Fee</td><td>270</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3.</td><td>ID Card</td><td>15</td><td></td><td>15</td><td></td><td>15</td><td></td><td>15</td><td></td><td>15</td><td></td></tr>
<tr><td>4.</td><td>SWF</td><td>15</td><td></td><td>15</td><td></td><td>15</td><td></td><td>15</td><td></td><td>15</td><td></td></tr>
<tr><td>5.</td><td>Library Fee</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>90</td><td>90</td><td>90</td><td>90</td></tr>
<tr><td>6.</td><td>Stationery Fee</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td></tr>
<tr><td rowspan="6">7.</td><td>Laboratory Fees</td><td colspan="10"></td></tr>
<tr><td>Chemistry</td><td>800</td><td rowspan="3">800</td><td rowspan="2">1200</td><td rowspan="5">2400</td><td rowspan="5">2400</td><td rowspan="5">2400</td><td rowspan="5">3000</td><td rowspan="5">3000</td><td rowspan="5">3000</td><td rowspan="5">3000</td></tr>
<tr><td>Physics</td><td>800</td></tr>
<tr><td>Life Sciences</td><td>800</td><td rowspan="2">1200</td></tr>
<tr><td>Computer Science</td><td rowspan="2"></td><td>800</td></tr>
<tr><td>Environmental Sci.</td><td>800</td><td></td></tr>
<tr><td>8.</td><td>Medical Insp. Fee</td><td>5</td><td></td><td>5</td><td></td><td>5</td><td></td><td>5</td><td></td><td>5</td><td></td></tr>
<tr><td>9.</td><td>Calendar Fee</td><td>40</td><td></td><td>40</td><td></td><td>40</td><td></td><td>40</td><td></td><td>40</td><td></td></tr>
<tr><td>10.</td><td>Magazine Fee</td><td>35</td><td></td><td>35</td><td></td><td>35</td><td></td><td>35</td><td></td><td>35</td><td></td></tr>
<tr><td>11.</td><td>Association Fee</td><td>35</td><td></td><td>35</td><td></td><td>35</td><td></td><td>35</td><td></td><td>35</td><td></td></tr>
<tr><td>12.</td><td>Audio Visual</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td></tr>
<tr><td>13.</td><td>Quasi University Fee</td><td>10</td><td></td><td>10</td><td></td><td>10</td><td></td><td>10</td><td></td><td>10</td><td></td></tr>
<tr><td>14.</td><td>Caution Deposit</td><td>2000</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>15.</td><td>Group Insurance Fee</td><td>2</td><td></td><td>2</td><td></td><td>2</td><td></td><td>2</td><td></td><td>2</td><td></td></tr>
<tr><td></td><td>Total/semester</td><td>8207</td><td>5780</td><td>5937</td><td>5780</td><td>5937</td><td>5780</td><td>7967</td><td>7810</td><td>7967</td><td>7810</td></tr>
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GENERAL SCHEME OF CURRICULUM

(5 year Integrated Master of Science Programme)

CH=Chemistry	**GE**= General	**EL**=English	**L**= Lecture hrs
PH=Physics	**OC**=Open Course	**ML**=Malayalam	**T**= Tutorial hrs
LS=Life Sciences	**SM**=Seminar	**HL**=Hindi	**P**= Practical hrs
CS=Computer Science	**VV**=Viva-Voce	**SL**=Sanskrit	**C**=Credits
ES=Environmental Science	**PV**=Project &Viva-Voce	**AL**=Arabic	
MM= Mathematics	**n**=1,2,3..etc (elective number)	**FL**=French	

Course structure:

- A 'major' course means the course from the major discipline in which a student gets admission.
- The curricula for 1st semester are completely common for all disciplines and all cources are mandatory.
- 2nd, 3rd and 4thsemesters consists of general courses as well as common/optional courses from the offering disciplines
- Mathematics courses are spread across initial 4 semesters and 1st semester course is mandatory for all.
- Mandatory English language courses form part of 1st and 2nd semesters, while second language elective courses (Malayalam, Hindi, Sanskrit, Arabic or French) are included in the 3rd& 4th semesters.
- Option for open course from social science integrated programme is provided in the third semester.
- 4th semester also consist of core and elective courses from the major discipline.
- 5thand 6thsemesters exclusively consist of core and elective courses from the discipline of choice and a minor research project at end of the sixth semester.
- 7th to 9thsemester consist of the advanced level courses in the major discipline
- Final 10th semester is completely set aside for a major research project and Viva-Voce
- Open course in the 9th semester shall be opted from any other teaching schools of the campus.
- There shall be flexibility to include the new open courses and elective courses dpending upon the recent advances in various disciplines

FOUNDATION LEVEL COURSES (I to VI Semesters): Total 120 credits

SEMESTER I

Code	Course	L	T	P	C
IMSC101CH	Chemistry-1	3	1	0	3
IMSC102PH	Physics-1	3	1	0	3
IMSC103LS	Life Science-1	3	1	0	3
IMSC104MM	Mathematics-1	3	1	0	3
IMSC105CS	Computer Science-1	3	1	0	3
IMSC106EL	English Language-1	2	1	0	2
IMSC107CH	Chemistry Lab -1	0	0	3	1
IMSC108PH	Physics lab-1	0	0	3	1
IMSC109LS	Life Science lab-1	0	0	3	1
	Total	**17**	**6**	**9**	**20**

SEMESTER II

Code	Course	L	T	P	C
IMSC201GE	Science Education	2	1	0	2
IMSE202CH/PH	Chemistry-2/ Physics-2	3	1	0	3
IMSE203LS/MM	Life Science-2/Mathematics-2	3	1	0	3
IMSC204CS	Computer Science-2	3	1	0	3
IMSC205ES	Environmental Science-1	3	1	0	3
IMSC206EL	English Language-2	2	1	0	2
IMSE207CH/PH/LS	Chem. Lab-2/Physics lab-2/ Life Science Lab-2	0	0	3	1
IMSC208ES	Environmental lab -1	0	0	3	1
IMSC209CS	Computer lab-1	0	0	3	1
IMSC210SM	Seminar	0	2	0	1
	Total	**17**	**6**	**9**	**20**

SEMESTER III					
Code	**Course**	**L**	**T**	**P**	**C**
IMSE301CH/PH	Chemistry-3/Physics-3	3	1	0	3
IMSE302LS/MM	Life Science -3/ Mathematics-3	3	1	0	3
IMSE303CS/ES	Comp. Science-3/Environ. Science-2	3	1	0	3
IMSE304M/H/S/A/F L	Second Language (M/H/S/A/F Elective)-1	2	1	0	2
IMSE305CH/PH/CS	Chem. lab 3 /Phy. lab 3/Comp. lab 2	0	0	3	1
IMSE306LS/CS	Life Science lab-3/Computer lab-3	0	0	3	1
IMSO307OC-n (n=1,2,3...)	Open Course[#]	4	0	0	4
IMSC308SM	Seminar	0	2	0	1
IMSC308VV	Comprehensive Viva-Voce	0	0	0	2
	Total	**14**	**7**	**6**	**20**
[#] Option to choose from Integrated MA program					

SEMESTER IV					
Code	**Course**	**L**	**T**	**P**	**C**
IMSE401CH/PH/CS	Chemistry-4/ Physics-4/ Comp. Science-4	3	1	0	3
IMSE402LS/MM/ES	Life Science -4/ Maths-4/ Envi. Science-3	3	1	0	3
IMSC403GE	Academic writing	2	1	0	2
IMSE404M/H/S/A/F L	Second Language (M/H/S/A/F Elective)-2	2	1	0	2
IMSE405GE-n (n=1,2,3...)	General (Elective)-1*	2	1	0	2
IMSC406CH/PH/LS/CS/ES	Major Lab -1	0	0	6	2
IMSC407CH/PH/LS/CS/ES	Major Lab -2	0	0	6	2
IMSE408CH/PH/LS/CS/ES-n (n=1,2,3...)	Major (Elective) -1	2	1	0	2
	Major (Elective) -2	2	1	0	2
	Total	**16**	**7**	**12**	**20**
*Social science/Management/Behavioural Science Electives					

SEMESTER V					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC501CH/PH/LS/CS/ES	Major -1	3	1	0	3
IMSC502CH/PH/LS/CS/ES	Major-2	3	1	0	3
IMSC503CH/PH/LS/CS/ES	Major -3	3	1	0	3
IMSC504CH/PH/LS/CS/ES	Major -4	3	1	0	3
IMSC505CH/PH/LS/CS/ES	Major lab -3	0	0	6	2
IMSC506CH/PH/LS/CS/ES	Major lab -4	0	0	6	2
IMSE507CH/PH/LS/CS/ES-n (n=1,2,3...)	Major (Elective)-3	2	1	0	2
IMSC508SM	Review Documentation/Seminar	0	2	0	2
	Total	**14**	**7**	**12**	**20**

SEMESTER VI					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC601CH/PH/LS/CS/ES	Major -5	3	1	0	3
IMSC602CH/PH/LS/CS/ES	Major -6	3	1	0	3
IMSC603CH/PH/LS/CS/ES	Major -7	3	1	0	3
IMSC604CH/PH/LS/CS/ES	Major lab-5	0	0	6	2
IMSC605CH/PH/LS/CS/ES	Major lab-6	0	0	6	2
IMSE606CH/PH/LS/CS/ES-n (n=1,2,3...)	Major (Elective)-4	2	1	0	2
	Major (Elective)-5	2	1	0	2
IMSC607PV	Minor Project and Viva-Voce	0	0	0	3
	Total	**13**	**5**	**12**	**20**

GENERAL SCHEME OF CURRICULUM

ADVANCED LEVEL COURSES (VII to X Semesters): Total 80 Credits

Note: Total credits for advanced level courses shall be 80 (last four semesters). However there shall be flexibility in the minimum/maximum requirement of credits for core and elective courses in each semester as well as for whole programme.

SEMESTER VII						Credits/ Semester
Code	**Course**	**L**	**T**	**P**	**C**	
IMSC70...CH/PH/LS/CS/ES	PG Major Courses (3-6 Nos)				3-4	20
IMSE70...CH/PH/LS/CS/ES-n (n=1,2,3...)	PG Major Electives (0-3 Nos)				1-3	
SEMESTER VIII						
Code	**Course**	**L**	**T**	**P**	**C**	20
IMSC80...CH/PH/LS/CS/ES	PG Major Courses (3-6 Nos)				3-4	
IMSE80...CH/PH/LS/CS/ES-n (n=1,2,3...)	PG Major Electives (0-3 Nos)				1-3	
SEMESTER IX						
Code	**Course**	**L**	**T**	**P**	**C**	20
IMSC90...CH/PH/LS/CS/ES	PG Major Courses (3-6 Nos)				3-4	
IMSE90...CH/PH/LS/CS/ES	PG Major Electives (0-3 Nos)				1-3	
IMSO906OC-n (n=1,2,3...)	Open Course				4	
SEMESTER X						
Code	**Course**	**L**	**T**	**P**	**C**	20
IMSC100PR	Major Research Project				16	
IMSC100VV	Comprehensive Viva-voce				4	

OUTLINE OF THE CURRICULUM
FOUNDATION LEVEL COURSES (I to VI Semesters): Total 120 credits

SEMESTER I

Code		Course	L	T	P	C
IMSC101	CH	Introductory Chemistry	3	1	0	3
IMSC102	PH	World of Physics	3	1	0	3
IMSC103	LS	Basic Cell Biology	3	1	0	3
IMSC104	MM	Linear Algebra and Numerical methods	3	1	0	3
IMSC105	CS	Fundamentals of Digital Systems	3	1	0	3
IMSC106	EL	The four skills for communication	2	1	0	2
IMSC107	CH	General Chemistry Lab	0	0	3	1
IMSC108	PH	General Physics Lab-1	0	0	3	1
IMSC109	LS	Cell Biology Lab	0	0	3	1
		Total	**17**	**6**	**9**	**20**

SEMESTER II

IMSC201	GE	ScienceEducation	2	1	0	2
IMSE202	CH	Physical Chemistry-1	3	1	0	3
	PH	Mechanics				
IMSE203	LS	Microbiology	3	1	0	3
	MM	Ordinary Differential Equations, Probability and Statistics				
IMSC204	CS	Methodology of Programmimg using C	3	1	0	3
IMSC205	ES	Introduction to Environmental Sciences	3	1	0	3
IMSC206	EL	Evolution of the Philosophy of Science: Literary Perspectives	2	1	0	1
IMSE207	CH	Physical Chemistry Lab-1	0	0	3	1
	PH	General Physics Lab-2				
	LS	Microbiology Lab-1				
IMSC208	ES	Environmental Sciences Lab-Field Practical	0	0	3	1
IMSC209	CS	C Programming Lab	0	0	3	1
IMSC210	SM	Seminar	0	2	0	1
		Total	**16**	**8**	**9**	**20**

SEMESTER III

IMSE301	CH	Organic Chemistry-1	3	1	0	3
	PH	Waves and Oscillations				
IMSE302	LS	Plant Diversity	3	1	0	3
	MM	Calculus and Vector Calculus				
IMSE303	CS	Computer Organization and Architecture	3	1	0	3
	ES	Physical systems of Environment				
IMSE304	ML	അനുഭവാഖ്യാനങ്ങൾ(Anubhavaagyanagal)	2	1	0	2
	HL	गद्यऔरएकांकी(Prose & One-Act Plays)				
	SL	Fundamentals of Sanskrit Language & Poetry				
	AL	Introductory Arabic				
	FL	Fundamentals of French Language				
IMSE305	CH	Organic Chemistry Lab-1	0	0	3	1
	PH	Waves and Oscillations Lab				
	CS	Internet Technologies Lab				
IMSE306	LS	Microbiology Lab -2	0	0	3	1
	CS	Web Programming Lab				
IMSO307	OC-n	Open Course(n=1,2,3...)	4	0	0	4
IMSC308	SM	Seminar	0	2	0	1
IMSC309	VV	Comprehensive Viva-Voce	0	0	0	2
		Total	**15**	**6**	**6**	**20**

SEMESTER IV						
Code		**Course**	**L**	**T**	**P**	**C**
IMSE401	CH	Inorganic Chemistry-1	3	1	0	3
	PH	Classical Mechanics-1				
	CS	Operating Systems				
IMSE402	LS	Animal Diversity	3	1	0	3
	MM	Integral Transforms and Partial Differential Equations				
	ES	Air, Water and Soil Chemistry				
IMSE403	GE	Academic Writing	2	1	0	2
IMSE404	ML	സാഹിത്യപഠനം(Saahithyapadanam)	2	1	0	2
	HL	**कविता और व्याकरण**(Poetry & Grammar)				
	SL	Scientific Literature in Sanskrit				
	AL	Arabic Communication				
	FL	Inter médiate French				
IMSE405	GE-n	1. Principles of Management 2. Disability and Rehabilitation 3. Understanding Social Justice 4. Constitutionalism, Legality and Justice in India 5. Public Health and Global Governance	2	1	0	2
IMSC406	CH	Inorganic Chemistry Lab-1	0	0	6	2
	PH	Electricity & MagnetismLab				
	LS	Animal Diversity Lab				
	CS	Data Structures Using C-Lab				
	ES	Inorganic Chemistry Lab-1				
IMSC407	CH	Organic Chemistry Lab-1	0	0	6	2
	PH	Heat and Thermodynamics Lab				
	LS	Plant Diversity Lab				
	CS	Microprocessor Lab				
	ES	Water Quality Analysis Lab				
IMSE408	CH-n	1. Polymer Chemistry 2. Environmental Chemistry 3. Green Chemistry				
	PH-n	1. Electricity and Elecrodynamics 2. Basic Electronics 3. Smart Materials and Soft Matter 4. Material Science and Engineering				
	LS-n	1. Molecules of Living Systems 2. Plant Physiology 3. Green Chemistry	2 2	1 1	0 0	2 2
	CS-n	1. Microprocessor & Assembly Language Programming 2. Data Structures 3. Computer Architecture				
	ES-n	1. Green Chemistry 2. Environmental Legislation 3. Natural Resources				
(n=1,2,3...)**Total**			**16**	**7**	**12**	**20**

SEMESTER V & VI (List of Courses Under Chemistry Major)					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC501CH	Physical Chemistry-2	3	1	0	3
IMSC502CH	Theoretical Chemistry	3	1	0	3
IMSC503CH	Organic Chemistry-2	3	1	0	3
IMSC504CH	Organic Chemistry-3	3	1	0	3
IMSC505CH	Physical Chemistry Lab-2	0	0	6	2
IMSC506CH	Inorganic Chemistry lab-2	0	0	6	2
IMSE507CH-n (n=1,2,3...)	1. Biochemistry 2. Computational Chemistry	2	1	0	2
IMSC508SM	Review Documentation and Seminar	0	2	0	2
	Total	**14**	**7**	**12**	**20**
IMSC601CH	Physical Chemistry-3	3	1	0	3
IMSC602CH	Inorganic Chemistry-2	3	1	0	3
IMSC603CH	Organic Chemistry-4	3	1	0	3
IMSC604CH	Physical Chemistry lab-3	0	0	6	2
IMSC605CH	Organic Chemistry Lab-3	0	0	6	2
IMSE606CH-n (n=1,2,3...)	1. Nano Materials 2. Medicinal Chemistry 3. Supramolecular Chemistry	2 2	1 1	0 0	2 2
IMSC607PV	Minor Project and Viva-Voce	0	0	0	3
	Total	**13**	**5**	**12**	**20**

SEMESTER V & VI (List of Courses Under Physics Major)					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC501PH	Classical Optics	3	1	0	3
IMSC502PH	Introductory to Quantum Theory and Special Relativity	3	1	0	3
IMSC503PH	Thermodynamics	3	1	0	3
IMSC504PH	Statistical mechanics-I	3	1	0	3
IMSC505PH	Semiconductor Physics and Solid State Physics Lab	0	0	6	2
IMSC506PH	Electronics Lab	0	0	6	2
IMSE507PH-n (n=1,2,3...)	1. Relativity, Astronomy and Astro Physics 2. Digital Electronics and Programming 3. Electronics-2	2	1	0	2
IMSC508SM	Review Documentation and Seminar	0	2	0	2
	Total	**14**	**7**	**12**	**20**
IMSC601PH	Solid State Physics-I	3	1	0	3
IMSC602PH	Spectroscopy-I	3	1	0	3
IMSC603PH	Nuclear and Particle Physics-I	3	1	0	3
IMSC604PH	Advanced Physics Lab-1	0	0	6	2
IMSC605PH	Advanced Physics Lab-2	0	0	6	2
IMSE606PH-n (n=1,2,3...)	1. Computational Physics 2. Fundamentals of Lasers and Fibre optics 3. Non Linear Optics & Laser Physics 4. High Energy Physics	2 2	1 1	0 0	2 2
IMSC607PV	Minor Project and Viva-Voce	0	0	0	3
	Total	**13**	**5**	**12**	**20**

SEMESTER V & VI (List of Courses Under Life Sciences Major)					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC501LS	Animal Physiology	3	1	0	3
IMSC502LS	Biophysical Techniques	3	1	0	3
IMSC503LS	Research Methodology& Biostatistics	3	1	0	3
IMSC504LS	Wildlife Biology	3	1	0	3
IMSC505LS	Molecules of Living Systems, Plant/Animal Physiology-Lab	0	0	6	2
IMSC506LS	Biophysical Techniques & Biostatistics-Lab	0	0	6	2
IMSE507LS-n (n=1,2,3...)	1. Plant Cell Culture 2. Animal Cell Culture	2	1	0	2
IMSC508SM	Review Documentation and Seminar	0	2	0	2
	Total	**14**	**7**	**12**	**20**
IMSC601LS	Genetics	3	1	0	3
IMSC602LS	Biotechnology	3	1	0	3
IMSC603LS	Biosafety, Bioethics and IPR Issues	3	1	0	3
IMSC604LS	Genetics Lab	0	0	6	2
IMSC605LS	Biotechnology Lab	0	0	6	2
IMSE606LS-n (n=1,2,3...)	1. Virology 2. Natural Hazards & Introduction to Disaster Management 3. Nano Materials	2 2	1 1	0 0	2 2
IMSC607PV	Minor Project and Viva-Voce	0	0	0	3
	Total	**13**	**5**	**12**	**20**

SEMESTER V and VI (List of Courses Under Computer Science Major)					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC501CS	Object Oriented Programming with C++	3	1	0	3
IMSC502CS	Data Communications and Networking	3	1	0	3
IMSC503CS	Design and Analysis of Algorithms	3	1	0	3
IMSC504CS	Database Management Systems	3	1	0	3
IMSC505CS	Programming with C++ (Lab)	0	0	6	2
IMSC506CS	DBMS Lab	0	0	6	2
IMSE507CS-n (n=1,2,3...)	1. Software Engineering 2. Compiler Construction	2	1	0	2
IMSC508SM	Review Documentation and Seminar				
	Total	**14**	**7**	**12**	**20**
IMSC601CS	Systems Programming	3	1	0	3
IMSC602CS	Security in Computing	3	1	0	3
IMSC603CS	Machine Learning	3	1	0	3
IMSC604CS	Java Programmimg	0	0	6	2
IMSC605CS	Machine Learning Lab (Matlab/Python)	0	0	6	2
IMSE606CS-n (n=1,2,3...)	1. Introduction to Artificial Intelligence 2. Computer Graphics 3. Fuzzy and Evolutionary Computing	2 2	1 1	0 0	2 2
IMSC607PV	Minor Project and Viva-Voce	0	0	0	3
	Total	**13**	**5**	**12**	**20**

SEMESTER V and VI (List of Courses Under Environmental Sceince Major)					
Code	**Course**	**L**	T	P	C
IMSC501ES	Ecology and Biodiversity Conservation	3	1	0	3
IMSC502ES	Water Resources	3	1	0	3
IMSC503ES	Environmental Pollution	3	1	0	3
IMSC504ES	Energy Resources	3	1	0	3
IMSC505ES	Ecology Lab	0	0	6	2
IMSC506ES	Inorganic Chemistry lab -2	0	0	6	2
IMSE507ES-n (n=1,2,3...)	1. Biochemistry 2. Human-wildlife conflict	2	1	0	2
IMSC508SM	Review Documentation and Seminar	0	2	0	2
	Total	**14**	**7**	**12**	**20**
IMSC601ES	Basics of Environmental Biotechnology	3	1	0	3
IMSC602ES	Biogeochemistry	3	1	0	3
IMSC603ES	Climate Change	3	1	0	3
IMSC604ES	Soil & Water Quality Analysis-Lab	0	0	6	2
IMSC605ES	Air Analysis & Remote Sensing and GIS-Lab	0	0	6	2
IMSE606ES-n (n=1,2,3...)	1. Nano materials 2. Natural Hazards& Introduction to Disaster Management 3. Remote sensing and GIS	2 2	1 1	0 0	2 2
IMSC607PV	Minor Project and Viva-Voce	0	0	0	3
	Total	**13**	**5**	**12**	**20**

OUTLINE OF THE CURRICULUM

ADVANCED LEVEL COURSES (VII to X Semesters): Total 80 Credits

(List of Courses Under Chemistry Major)					
SEMESTER VII					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC701CH	Theoretical Aspects in Chemistry	3	1	0	3
IMSC702CH	Advanced Coordination Chemistry	3	1	0	3
IMSC703CH	Chemical Thermodynamics	3	1	0	3
IMSC704CH	Organic Reaction Mechanisms	3	1	0	3
IMSC705CH	Stereochemistry andAsymmetric Synthesis	3	1	0	3
IMSC706CH	Inorganic Chemistry Lab	0	0	6	2
IMSE707CH-n (n=1,2,3...)	1. Chemistry of Main Group elements 2. Advanced Polymer Chemistry 3. Material Chemistry	2	0	0	3
	Total	**20**	**5**	**6**	**20**
SEMESTER VIII					
IMSC801CH	Structural Inorganic Chemistry	3	1	0	3
IMSC802CH	Molecular spectroscopy	3	1	0	3
IMSC803CH	Advanced Physical Chemistry	3	1	0	3
IMSC804CH	Reactions & Reagents in Organic Synthesis	3	1	0	3
IMSC805CH	Physical Chemistry Lab	0	0	6	2
IMSC806CH	Organic Chemistry Lab	0	0	6	2
IMSE807CH-n (n=1,2,3...)	1. Photochemistry and Pericyclic Reactions 2. Bioinorganic Chemistry 3. Polymer Materials 4. Natural Products Chemistry	2 2	0 0	0 0	2 2
	Total	**16**	**4**	**12**	**20**
SEMESTER IX					
IMSC901CH	Instrumental Methods of Chemical Analysis	3	1	0	3
IMSC902CH	Organometallics	3	1	0	3
IMSC903CH	Advanced Organic Synthesis	3	1	0	3
IMSC904CH	Chemical Kinetics and Catalysis	3	1	0	3
IMSC905CH	Advanced Characterisation lab	0	0	6	2
IMSO906OC-n (n=1,2,3...)	Open Course	4	0	0	4
IMSE907CH-n (n=1,2,3...)	1. Cheminformatics 2. Analytical & Nuclear Chemistry 3. Heterocyclic Chemistry	2	0	0	2
	Total	**18**	**4**	**6**	**20**
SEMESTER X					
IMSC100PR	Major Research Project	0	0	0	16
IMSC100VV	Comprehensive Viva-voce	0	0	0	4
	Total	**0**	**0**	**0**	**20**

SEMESTER VII to X (List of Courses Under Physics Major)					
SEMESTER VII					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC701PH	Basic Electronics	4	1	0	4
IMSC702PH	Mathematical Methods in Physics	4	1	0	4
IMSC703PH	Electrodynamics	4	1	0	4
IMSC704PH	Classical Mechnanics	4	1	0	4
IMSC705PH	ElectronicsLab	0	0	6	4
	Total	**20**	**4**	**6**	**20**
SEMESTER VIII					
IMSC801PH	Quantum Mechanics-I	3	1	0	3
IMSC802PH	Mathematical Physics	3	1	0	3
IMSC803PH	Solid State Physics	3	1	0	3
IMSC804PH	Statistical Mechanics	3	1	0	3
IMSC805PH	Nuclear Physics	3	1	0	3
IMSC806PH	General Physcis Lab	0	0	6	3
IMSE807PH-n (n=1,2,3...)	1. Elective-1 2. Elective-2	2	1	0	2
	Total	**17**	**5**	**6**	**20**
SEMESTER IX					
IMSC901PH	Quantum Mechanics-II	4	1	0	4
IMSC902PH	Spectroscopy	4	1	0	4
IMSC903PH	Advanced Practical	0	0	4	2
IMSC904PH	Minor Project	0	0	2	2
IMSE905PH-n (n=1,2,3...)	1. Elective-1 2. Elective-2 3. Elective-3	2 2	1 1	0 0	2 2
IMSO906OC-n (n=1,2,3...)	Open Course	4	0	0	4
	Total	**16**	**4**	**6**	**20**
SEMESTER X					
IMSC100PR	Major Research Project	0	0	0	16
IMSC100VV	Comprehensive Viva-voce	0	0	0	4
	Total	**0**	**0**	**0**	**20**

SEMESTER VII to X (List of Courses Under Life Sciences Major)					
SEMESTER VII					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC701LS	Genetics	3	1	0	3
IMSC702LS	Developmental Biology	3	1	0	3
IMSC703LS	Enzymology	3	1	0	3
IMSC704LS	Molecular and Cellular Biology	3	1	0	3
IMSC705LS	Lab Course-1	0	0	6	4
IMSE706LS-n (n=1,2,3...)	1. Chemical Biology 2. Microbial Biotechnology 3. Glycobiology 4. Metabolic Basis of Health and Disease 5. Plant Developmental Biology	2 2	0 0	0 0	2 2
	Total	**16**	**4**	**6**	**20**
SEMESTER VIII					
IMSC801LS	Immunology and Infectious Diseases	3	1	0	3
IMSC802LS	Entomology	3	1	0	3
IMSC803LS	Organismic and Evolutionary Biology	3	1	0	3
IMSC804LS	Systems Biology	3	1	0	3
IMSC805LS	Lab Course-2	0	0	6	4
IMSE806LS-n (n=1,2,3...)	1. Nutritional Biochemistry 2. Toxicology 3. Biophysics and Structural Biology 4. Bioanalytical Techniques and Instrumentation 5. Bioinformatics and Integrative Genomics	2 2	0 0	0 0	2 2
	Total	**16**	**4**	**6**	**20**
SEMESTER IX					
IMSC901LS	Plant Molecular Biology	3	1	0	3
IMSC902LS	Neuroscience	3	1	0	3
IMSC903LS	Recombinant DNA Technology	3	1	0	3
IMSC904LS	Lab Course-3	0	0	6	4
IMSE905LS-n (n=1,2,3...)	1. Biostatistics 2. Molecular Parasitology 3. Ethnopharmacology	3	0	0	3
IMSO906OC-n (n=1,2,3...)	Open Course	4	0	0	4
	Total	**19**	**3**	**6**	**20**
SEMESTER X					
IMSC100PR	Major Research Project	0	0	0	16
IMSC100VV	Comprehensive Viva-voce	0	0	0	4
	Total	**0**	**0**	**0**	**20**

SEMESTER VII to X (List of Courses Under Computer Science Major)					
SEMESTER VII					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC701CS	Operating Systems- Design Principles	3	1	0	3
IMSC702CS	Theoretical Computer Science	4	1	0	4
IMSC703CS	Wireless Communications	4	1	0	4
IMSC704CS	Advanced Java Programming	4	1	0	4
IMSC705CS	Java Programming Lab	0	2	6	2
IMSE706CS-n (n=1,2,3...)	1. Advanced Microprocessors 2. Advanced Computer Architecture	3	0	0	3
	Total	**20**	**6**	**6**	**20**
SEMESTER VIII					
IMSC801CS	Advanced Database Management Systems	2	1	2	3
IMSC802CS	Digital Image Processing	3	1	2	4
IMSC803CS	AI and Deep Learning	4	1	0	4
IMSC804CS	Data Mining	3	1	3	4
IMSC805CS	AI Lab	0	0	6	2
IMSE806CS-n (n=1,2,3...)	1. Cloud Computing 2. Distributed Systems	3	0	0	3
	Total	**15**	**4**	**13**	**20**
SEMESTER IX					
IMSC901CS	Data Analytics	2	1	2	3
IMSC902CS	Advanced Data Structures	2	1	2	3
IMSC903CS	Advanced Computer Security	2	1	2	3
IMSE904CS-n (n=1,2,3...)	1. Computer Vision 2. Speech and Natural Language Processing 3. Mobile Computing	3	0	0	3
IMSE905CS-n (n=1,2,3...)	1. Introduction to Block Chain 2. Internet of Things	2	0	0	2
IMSO906OC-n (n=1,2,3...)	Open Course	4	0	0	4
IMSC907CS	Minor Project	0	0	6	2
	Total	**15**	**3**	**12**	**20**
SEMESTER X					
IMSC100 PR	Major Research Project	0	0	0	16
IMSC100 VV	Comprehensive Viva-voce	0	0	0	4
	Total	**0**	**0**	**0**	**20**

SEMESTER VII to X (List of Courses Under Environmental Science Major)					
SEMESTER VII					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC701ES	Ecology and Environment	2	2	0	3
IMSC702ES	Environmental Geosciences	3	2	0	4
IMSC703ES	Environmental Chemistry and Pollution	2	2	0	3
IMSC704ES	Research Methodology	2	2	0	3
IMSC704ES	Conservation Biology	2	2	0	3
IMSC705ES	Lab course-I (Environmental Pollution and Geology)	0	0	6	3
IMSE706ES	Field Study	0	1	2	2
	Total	**11**	**11**	**8**	**20**
SEMESTER VIII					
IMSC801ES	Analytical Techniques and Instrumentation	3	2	0	4
IMSC802ES	Environmental Biotechnology and Waste Management	2	2	0	3
IMSC803ES	Environmental Economics and Sustainable Development	2	2	0	3
IMSC804ES	Environmental Microbiology	2	2	0	3
IMSC805ES	Lab course-II (Ecology, Environmental microbiology, RS & GIS)	0	0	6	3
IMSE806ES-n (n=1,2,3...)	1. Ecotoxicology 2. Water resources management 3. Sanitation and Health	2	1	0	2
	Total	**11**	**9**	**6**	**20**
SEMESTER IX					
IMSC901ES	Resource Management	3	2	0	4
IMSC902ES	Environmental Engineering	2	2	0	3
IMSC903ES	Environment Management	2	2	0	3
IMSC904ES	Advanced Geomatics and Applications	2	2	0	3
IMSC905ES	Environment Impact Assessment	2	1	0	2
IMSC906OC-n(n=1,2,3...)	Open Course	4	0	0	4
IMSE907ES	Seminar- Current issues & trends in Environmental Science	0	2	0	1
	Total	**11**	**11**	**0**	**20**
SEMESTER X					
IMSC100PR	Major Research Project	0	0	0	16
IMSC100VV	Comprehensive Viva-voce	0	0	0	4
	Total	**0**	**0**	**0**	**20**

DETAILED SYLLABI
Foundation Level Courses (I to VI Semesters)

SEMESTER I

IMSC101CH Introductory Chemistry

Credits 3(3-1-0)

Module I: Chemistry: A colourful science
Evolution of chemistry-alchemy, ancient concepts to particulate nature of matter, laws of chemical combination. Branches of chemistry, interdisciplinary areas involving Chemistry. Relevance of chemistry in everyday life-industry, agriculture, food, medicine, textile, building materials (paint, cement etc), plastics, rubber, etc. Power generation by chemical methods such as fission and fusion reactions - solar cells.

Module II: Atomic Structure &Chemical Bonding
Atomic Structure, Electronic Configuration, Atomic and ionic radii, ionization energy, electron affinity and electronegativity, trends in periodic table and applications in predicting and explaining the chemical behaviour. Covalent Bond -Valence bond theory and its limitations, hybridization, shapes of molecules and ions. Valence shell electron pair repulsion (VSEPR) theory, MO theory, homonuclear diatomic molecules, bond strength and bond radius. Polarity in covalent compounds, Fajans rule. Weak Interactions – Hydrogen bonding, Van der Waals forces.

Module III: Acids & Bases Concepts
Arrhenius definition, Bronsted-Lowry definition and conjugate acid-base pairs, lewis concept, ionization of acids and bases. Metal and nonmetal hydroxy compounds, acid anhydrides, amphoteric oxides and hydroxides. Hard and soft acids and bases, Applications of HSAB concept, limitations of HSAB concept.

Module IV: States of Matter-Gaseous state
kinetic theory of gases, deviation from ideal behavior. Law of corresponding states. Molecular velocities, Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter,Compressibility factor -van der Waals equation of state (virial equation), PV isotherms of real gases, Continuity of states - Critical phenomena - Critical constants and their determination, Liquefaction of gases (based on Joule Thomson- effect) Intermolecular forces, structure of liquid. Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesteric phases.

Module V: Introductory Organic Chemistry
IUPAC nomenclature: Alkanes, cyclo-alkanes, alkenes, alkynes, halogen compounds,Functional groups and structural diversity, Conformational analysis :alcohols, ethers, aldehydes, ketones, carboxylic acids, nitro compounds. Hybridization and Geometry of Molecules: methane, ethane, ethylene, acetylene. Electronic Effects: Inductive, resonance, hyper conjugation and steric effect. Cleavage of bonds: homolytic and heterolytic C-C bond fission. Reaction Intermediates and their stability: carbocations, carbanions and free radicals.

Module VI: Basics of Stereochemistry
Introduction, Concept of Isomerism, Classification of Stereoisomers, Optical isomerism, Chirality & Elements of symmetry, Wedge formula, Fischer projection, Newmann projection. Relative and absolute configurations, sequence rules, D & L, R & S systems of nomenclature. Understanding with examples for Enantiomers, mesoform, erythro/threo forms, diastereoisomers, inversion, retention, and racemization. Conformational understanding with an example of ethane, n-butane, Cyclohexane and Decalin**.**

References:

1. *Basic Inorganic Chemistry by F. A. Cotton & Wilkinson, John Wiley*
2. *Inorganic Chemistry by J. E. Huhey, Harpes& Row*
3. *Fundamentals of Organic Chemistry, Solomons, John Wiley*
4. *Organic Chemistry, J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford Univ. Press, USA*
5. *Physical Chemistry Vol. 1-5, by K.L Kapoor*
6. *Physical Chemistry by P. W. Atkins, Elbs*

IMSC102PHWorld of Physics

Credits 3(3-1-0)

Module I: Development of Physics

An overview on ancient perspectives on the universe - Galileo, and his emphasis on experiments and observations, Kepler's laws, Newton and the deterministic universe, Maxwell and the unification of electricity, magnetism and optics, Fundamental particles and the unification of all forces of nature.

Planck's hypothesis of quantum, Quantum mechanics, Einstein and his theories of relativity, Contributions by the Great Indian Scientists - S. N. Bose, M. N. Saha, C. V. Raman, quantum theory of Raman effect Chandrasekhar's limit (details and derivations not required)

Module II: Units and Measurements of Physical quantities

Fundamental and derived quantities. Units and dimensions, dimensional analysis, order of magnitude, significant figures, errors.

Length measurement – rulers – standard metre – Vernier calipers - micrometers – screw gauges – travelling microscope – laser range finder- sonar, RADAR, GPS. Angle measurement – spectrometer - scale and telescope - measurement of stellar parallaxes.

Module III: Error analysis

Performance characteristics of an instrument – static characteristics – Error in measurement, Types of static error – Gross error, systematic errors, random errors, sources of error.

Statistical analysis: arithmetic mean, deviation from the mean, average deviations, standard deviation, limiting errors, graphical representation of measurements as a distribution.

Module IV: Mathematical Methods in Physics

Vector Analysis: – Vector Operations - Vector Algebra – Component form – How vectors transform, Applications of vectors in Physics. Differential Calculus: – The operator ∇ - Gradient, Divergence, Curl – Physical interpretation - Product rules of ∇ - Second derivatives.

Integral Calculus: – Line integral, surface integral and volume integral - Fundamental theorem of Gradients-Gauss's Divergence Theorem (Statement only)–The fundamental theorem of curl-Stoke's theorem(Statement only).Curvilinear co-ordinates:Spherical polar coordinates – cylindrical coordinates (Basic ideas).

References:-

1. *University Physics, Roger A Freedman, Hugh D Young 14th Edition*
2. *Mathematical Physics :- Charlie Harper*
3. *Principles of Physics:- Jearl Walker, David Halliday and Robert Resnick*
4. *The theory of Errors in Physical Measurements- J C Pal- New Central Book Agency- 2010*
5. *Feynman lectures of Physics*
6. *Concepts of Modern Physics: ArtherBeisser,*
7. *Modern Physics: Kenneth Krane*
8. *Statistical Methods, S.P Gupta, S.Chand &Co.*

IMSC103LS Basic Cell Biology

Credits 3(3-1-0)

Module I: History of Cell and Molecular Biology

History and scope of cell biology, Cell theory, Prokaryotes, Eukaryotes, Actinomycetes, Mycoplasma, Virus, Virion, Viroids and Prions

Module II: Cell membrae & Permeability

Molecular models of cell membrane - Sandwich model, Unit membrane model, Fluid mosaic model, Plasma membrane, Microvilli, tight junction, gap junction, desmosomes. Cell permeability - Diffusion, Osmosis, Passive transport, Active transport

Module III:Cell Organeles-Structure and Functions

Structure and functions of Endoplasmic reticulum, Ribosomes, Golgi Complex, Lysosomes, Peroxisomes, Proteosomes, Mitochondria, Plastids, Chloroplast, Centrioles and Basal bodies. Symbiont hypothesis. Cytoskeleton - Microtubules, microfilaments, intermediate filaments

Module IV:Nucleus

Structure of nucleus, nuclear membrane, pore complex, Nucleolus -Structure and functions, Chromatin - euchromatin and heterochromatin, different levels of chromatin organization, Chromosome - structure of

a typical metaphase chromosome; giant chromosomes, polytene chromosomes, lamp brush chromosomes; endomitosis

Module V:Cell Division
Cell cycle - G1, S, G2 and M phases, Mitosis – Stages. Meiosis – Stages

Module VI:Cell Communication
Cell signalling - Signalling molecules (neurotransmitters, hormones, growth factors, cytokines, vitamin A and D derivatives) , Role of cyclic AMP

Module VII:Biology of Cancer
Biology of cancer- characteristics of cancer cells, dedifferentiation of cancer cells,theories of cancer, carcinogenesis, oncogenes and tumor suppressor genes

References

1. *De- Robertis E.D. and De Robertis Jr.E.M.F 2002. Cell and Molecular Biology (Lea & Febiger/Info-Med)*
2. *James Darnell. 1998. Molecular Biology. Scientific American Books Inc. John Wiley and Sons New York.*
3. *Karp. G., 1996. Cell and Moecular Biology, Concepts and Experiments*
4. *Powar C.B. 1983. Cell Biology (Himalaya Pub. Company)*
5. *Rastogi S. C. 1998. Cell Biology. Tata Mc.Graw Hill Publishing Co., New Delhi*

IMSC104MM Linear Algebra and Numerical methods

Credits 3(3-1-0)

Module I: System of Equations and Matrices
Liner Equations, Gaussian Elimination, Matrix Operations, Inverse and Algebraic Properties of Matrices, Elementary Matrices and inverse, Diagonal, triangular and Symmetric Matrices .

Module II:Eigen Values and Eigen Vectors
Eigen Values and Eigen Vectors, Diagonalization Orthogonal Matrices Orthogonal Dagonalization

Module III: Euclidian Vector Spaces and General Vector Spaces
Vectors in 2- Space, 3- Space, and n- Space, Norm, dot product and distance in $\mathbb{R}^n$Orthogonality.

Module IV:General Vector Spaces
Real Vector Spaces,Sub spaces Linear Independence and Basis, Dimension .

Module V: Numerical Methods (Use of Non Programmable Scientific Calculator is Permitted)
Absolute, relative and percentage errors. A general error formula . Error in a series Approximation. Bisection Method , Methods of false position , Iteration Method , Acceleration of convergence: Aitken's Δ^2 Process, Newton Raphson Method, the quotient – Difference method .

References:

1. **Text 1**. *Howard Anton & Chris Rorres Elementary Linear Algebra with Supplementary Application Wiely Publication .inc 11th Edition*
2. **Text 2.***S.S . Sastry : Introductory methods of Numerical Analysis ,4th edn. (Prentice Hall)*
3. *Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.*
4. *G. Strang, "Linear Algebra and its Applications", 3rdEdition, Harcourt College Publishers, 1988.*

IMSC105CS Fundamentals of Digital Systems

Credits 3(3-1-0)

Module I: Number Systems:
Number Systems-Decimal, Binary, Octal and Hexadecimal, Conversion-From one number system to another, Concept of binary addition and subtraction, Complements in binary number systems,1s Complement, 2s Complement and their applications, Signed magnitude form, BCD numbers- concept and addition, Other Binary Codes, Error Detection Codes.

Module II:Logic Gates and Boolean Algebra:
Logic gates- AND, OR, NOT, NAND and NOR Truth tables and graphical representation, Basic laws of Boolean Algebra, Simplification of Expressions, De Morgans theorems, Dual expressions, Canonical expressions, Min terms and Max terms, SOP and POS expressions, Map Simplification, Parity generator and checker.

Module III: Sequential and Combinational Logic.
Flip flops- Latch, Clocked, RS, JK, T, D and Master slave , Adders-Half adder, Full adder, Encoders, Decoders, Multiplexers and Demultiplexers , Analog to digital and digital to analog converters, Concept of Registers, Counters, Shift Registers.

Module IV: Register Transfer and Micro operations:
Register Transfer Language, Register Transfer, Bus & Memory Transfer, Arithmetic Microoperations, Logic Microoperations, Shift Microoperations.

References

1. *M Morris Mano, Digital Logic and Computer Design, Fourth Edition, Prentice Hall.*
2. *Thomas C Bartee, Digital computer Fundamentals, Sixth Edition, TATA McGraw Hill.*
3. *Thomas L Floyd, Digital Fundamentals, Ninth edition, PEARSON Prentice Hall.*
4. *Malvino & Leach, Digital Principles and Applications, Sixth Edition, Tata McGraw Hill.*

IMSC106LE English Language-1

Credits 2(2-1-0)

The four skills for communication

Module I: **Communication, Listening and Speaking Skills**
English for communication- English as a Global language- listening to a conversation-listening to a speech- listening to a lecture- greeting – thanking-requesting- enquiring-explaining-reporting-permission

Module II: Reading and Writing
Reading news reports – reading charts, tables, graphs – reading advertisements – reading official letters – reading online content -writing sentences – paragraphs – reports – letters – resume – covering letters – writing e-mails – notes – blogs – punctuation marks

Module III: Grammar
Word class – subject - verb agreement – tenses – articles – phrases – clauses – sentences – voices –idioms

Required Reading:
Josh Sreedharan - *The Four Skills for Communication*: *An English Language Course*, Cambridge University Press, 2014

IMSC107CH General Chemistry Lab

Credit 1(0-0-3)

1. Basic Laboratory Skills- Demonstration & concept:
   Awareness of Material Safety Data Sheet (MSDS). Storage and handling of chemicals.
   Simple first aids: Electric shocks, fire, cut by glass and inhalation of poisonous gases - Accidents due to acids and alkalis - Burns due to phenol and bromine. Disposal of sodium and broken mercury thermometer ,
2. Use of calcium chloride and silica gel in desiccators. R & S Phrases (elementary idea only) – Safe laboratory practices – Lab safety signs. Personal Protective Equipment (PPE) Demonstration & concept of good lab practices including chemical/glassware handling and waste management.
3. Calibration and handling of balances, basic principles & experiments related to sample/reagent preparation: practical concept of Molarity, Molality, Normality, equivalence, weight %, vol.%, Preparation of standard solutions, Dilution 0.1 M to 0.001 M solutions.
4. Calibration of Thermometer using 80-82 °C (Naphthalene), 113.5-114 °C (Acetanilide) 132.5-133 °C (Urea), 100 °C (Distilled Water)
5. Determination of Melting Point(any three):Naphthalene 80-82 °C, Benzoic Acid 121.5-122 °C Urea 132.5-133 °C, Succinic Acid 184.5-185 ° C, Cinnamic Acid 132.5-133 °C, Salicylic Acid 157.5-158 °C Acetanilie 113.5-114 °C, m-Dinitrobenzene 90 °C p-Dichlorobenzene 52 °C, Aspirin 135 °C
6. Determination of Boiling Point (any one)a. Ethanol 78 °C, Cyclohexane 81.4 °C, Toluene 110.6 °C
7. Sublimation (Simple and Vacuum):Camphor, Naphtalene, Phthalic Acid and Succinic Acid

8. Volumetric analysis (Acidimetry and alkalimetry only):Titration of Strong acid – strong base, Strong acid – weak base , Weak acid – strong base titrations Estimation of NaHCO3 and Na2CO3 in a mixture , Estimation of NH3 by indirect method.

References:

1. *Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal*
2. *Vogel's Textbook of Practical Organic Chemistry (5th Edition)*
3. *Vogel's Inorganic Practical Chemistry*

IMSC108PH General Physics Lab-1

Credit 1 (0-0-3)

1. Symmetric Compound Pendulum – Determination of acceleration due to gravity (g), radius of gyration(K) and moment of inertia
2. Asymmetric Compound Pendulum – Determination of acceleration due to gravity (g), radius of gyration(K) and moment of inertia (I)
3. Kater's pendulum – Determination of acceleration due to gravity (g)
4. Torsion Pendulum – Determination of rigidity modulus (n) and moment of inertia(I)
5. Torsion Pendulum (Method of equal masses) – Determination of rigidity modulus (n) and moment of inertia (I)
6. Measurement of density of a solid – Sensibility method to find mass using beam balance and screw gauge / venier calipers for dimension measurements
7. Uniform bending – Pin and Microscope – Determination of Young's modulus
8. Non Uniform bending – Pin and Microscope – Determination of Young's modulus
9. Uniform bending – Optic Lever – Determination of Young's modulus
10. Non Uniform bending – Optic Lever – Determination of Young's modulus

Reference books

1. *Properties of Matter,D S Mathur*
2. *Practical Physics, P R Sasikumar Eastern Eco. Ed.*
3. *Advance level Practical Physics IV Ed., Nelkon and J M Ogborn*
4. *Advance course in Practical physics, D Chathopathyaya*
5. *Practical Physics,C L Arora*
6. *Electronics Lab Manuel , K A Navas*
7. *Digital fundamentals,Thomas L Floyed*
8. *A course of experiments with He-Ne Laser, R S Sirohi*
9. *Laboratory manael for introductory Electronic experiments, L K Maheswari & Nm S Anand*
10. *Optics, N Subramanyan, Brij Lal 7 Avadhanalu*

IMSC109LSCell Biology Lab

Credit 1 (0-0-3)

1. Study of microscope - parts of a compound microscope, use and maintenanceof a microscope.
2. Study of prokaryotic cells - Lacto bacillus
3. Study of eukaryotic cells - Buccal epithelial cells
4. Buccal smear – Identification of Barr Body.
5. Squash preparation of onion root tip to study mitotic stages.
6. Calculation of mitotic index
7. Study of meiosis – Grasshopper testis squash. (demo)
8. Identification of meiotic stages(slide/figure)
9. Laboratory Record

References

1. *Principles of Biology I Lab Manual, Susan Burran and David DesRochers*
2. *Rickwood, D. and J.R. Harris "Cell Biology : Essential Techniques", Johnwiley*

SEMESTER II

IMSC201GE ScienceEducation

Credits 2(2-1-0)

Module I: Philosophy of Science
Ancient Philosophy, Argumentation analysis,Types-Rhetorical and Dialogue,Positivism,Relativism,Realism

ModuleII: The History of Science
Ancient civilisation in India, china, Babylon, Egypt, Greece, Rome, Aristotelian views, Archimedes, The Copernican revolution,Contributions of Galileo, Louis Pasteur,Newton,Einstein, Linus Pauling, Development of science,New physics,Newtonian physics, Revolution in Biology, Chemistry, Mathematics, Computer Science ,Need of Environmental Education,Science in twenty first century

ModuleIII: Teaching critical thinking
Improving reasoning,Critical thinking, Affective strategies, Cognitive strategies, Media role, Science and knowledge, Beliefs, Justification, Maths in Science

ModuleIV: Science and society
Factors affecting scientific interaction, Positivist perspective, Social perspective, Ethical dilemmas, Proximatevs ultimate causation, Pseudoscience

Module V: Scientific ethics
Verifyibility and reproducibility, Plagiarism, IPR, Cyberlaws,Internet security

Module VI: CurrentTrends in Science
Latest developements in variousbranches of science and technology, Nobel Prizes, How science is changing the world, Science in future, Challenges and prospects

References

1. *Science in history, 1-4 Volumes ,J D Bernal, MIT Press,Cambridge,1971.*
2. *The Story of Civilization,, Will Durant, Simon and Schuster Publishers,, United States, 1975*
3. *The Scientific Outlook, Bertrand Russell, Routledge Classics*
4. *Science and Society, John Scales Avery, World scientific*
5. *The New Physics, C.V. Raman, Literary Licensing LLC, Wisconsin*
6. *Evolution of the Philosophy of Science-Literary Perspectives, K. Sujatha, and S. Kurien, AneBooks Pvt. Ltd, 2011.*
7. *One, two, three…infinity ,George Gammow, Dover Publications, INC, NewYork,1974*

IMSC202CH Physical Chemistry-1

Credits 3(3-1-0)

Module I: Chemical Thermodynamics
Thermodynamic terms, State and path functions. Concept of heat and work. First Law of thermodynamics, energy and enthalpy. Heat capacity. Joule's law - Joule - Thomson coefficient and inversion temperature. Calculation of w, q, dU&dH for the expansion of ideal gases under isothermal and adiabatic condition for reversible process. Maxwell's relations, Thermochemistry: Kirchhoff's equation. Second law of thermodynamics, Kelvin, Planck and Clausius statements. Calculation of entropy change for reversible and irreversible processes, free energy functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium. Carnot's theorem - Carnot's cycle and its efficiency.Gibbs-Helmholtz equation - Partial molar free energy - Concept of chemical potential, Fundamental concepts of Statistical Thermodynamics - Probability - Partition function - ensembles - Boltzmann distribution ,Sterling's approximation - Residual entropy and absolute entropy. Third law of thermodynamics - Nernst heat theorem

Module II: Chemical Equilibria.
Law of mass action, thermodynamic derivation of law of chemical equilibrium. Relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx (using chemical potential). Reaction isotherm and reaction isochore, Clausius – Clapeyron equation and applications.Van't Hoff's equation - Le Chatelier principle . Homogeneous and heterogenous equilibria.

Module III: Ionic Equilibria
Introduction to acid base theories – pKa, pKb and pH – Buffer solutions. Mechanism of buffer action – Buffer index – Henderson equation – Applications of buffers - Hydrolysis of salts of all types – Degree of hydrolysis – Hydrolysis constant and its relation with Kw - Solubility product and common ion effect.

Module IV: Fundamentals of Electrochemistry.
Introduction (Faradays law),conductance with dilution -Kohlrausch's law -Arrhenius theory ,Weak and strong electrolytes - Ostwald's dilution law, its applications and limitations -DebyeHuckel-Onsager's equation,Debye-Falkenhagen and Wein effects, Migration of ions and Transport number ,Applications of conductivity measurements: Determination of degree of dissociation, ionic product of water and solubility product of sparingly soluble salts ,Conductometric titrations

Module V: Solid State Chemistry
Amorphous and crystalline solids-Law of constancy of interfacial angles and rational indices, fundamentals of Space lattice and unit cell, crystal directions and planes, Direct and reciprocal lattice (Miller indices),Seven crystal systems and fourteen Bravaislattices,Crystal diffraction -Bragg's law Planes ,Simple account of rotating crystal method and powder pattern method, Simple, face centered and body centered cubic systems , Identification of cubic crystals from inter-planar ratio -Close packing of spheres -Structure of simple ionic compounds of the type AB (NaCl and CsCl) and AB2 (CaF2). Non-stoichiometric defects and applications, Anaisotropy, magnetic properties, Curie law, Curie-weiss law, ferromagnetism, ferri magnetism, antiferromagnetism

References:

1. *Physical Chemistry by Samuel Glasstone*
2. *Physical Chemistry by IRA. N. Levine TMH*
3. *Physical Chemistry Vol. 1-5, by K.L Kapoor*
4. *Physical Chemistry: A Molecular Approach by McQuarrie & Simon Viva*
5. *B.R. Puri, L.R. Sharma & M.S. Pathania, Principles of Physical Chemistry*

IMSC202PH Mechanics

Credits 3(3-1-0)

Module I: Motion,Work, Energy and Power
Velocity, acceleration, momentum, Motion in one and two dimensions with constant acceleration, Idea of inertia, force – Newtons laws of motion and application, law of conservation of momentum-applications. Newton's law of gravitation, acceleration due to gravity, mass and weight, apparent weight, weightlessness, projectile motion, Uniform circular motion, Friction. Work done by a constant force and a variable force; kinetic energy, work- energy theorem, power. Potential energy, potential energy of a spring. Conservation laws, Conservative forces, Conservation of energy for a particle: Energy function, Potential energy curve, Non conservative forces

Module II: Linear and Angular Momentum
Conservation of linear momentum, Centre of mass, Centre of mass frame of reference, Collision of two particles, conservation of momentum during collisions, Deflection of a moving particle by a particle at rest, Rockets, Angular momentum and torque, Motion under central force, Areal velocity, Conservation of angular momentum with examples

Module III: Dynamics of rigid bodies
Moment of inertia, Theorems of M.I with proof- Parallel and perpendicular axes theorem, Calculation of M.I of bodies of regular shapes rectangular lamina, uniform bar of rectangular cross section, annular disc, circular disc, solid sphere-K.E of a rotating body. Determination of M.I of a fly wheel (theory and experiment).

Module IV: Elasticity
Basic ideas on elasticity, relations connecting various elastic constants, bending of beams, bending moment, cantilever-derivation of expression for depression at loaded point, cantilever- Young's modulus (mirror and telescope), Non-Uniform bending, I –section girders, Uniform bending, torsion of a cylinder-angle of twist and angle of shear, torsion pendulum, determination of rigidity modulus using torsion pendulum (dynamical method), static torsion method.

References:-

1. *Fundamentals of Physics, Resnick, Halliday and Walker, 6th edition, Wiley*
2. *Mechanics, D S Mathur, S.Chand & Co. (2007)*
3. *University Physics, Sears and Zemansky, 10th edition, Addison – Wesley Series*
4. *Concepts of Physics, H.C. Verma, TMH*

IMSE203LS Microbiology

Credits 3(3-1-0)

Module I: Introduction to Microbiology

History of microbiology. Microbial diversity, Major groups and their characteristics, Microbial taxonomy and phylogeny, Classification of Bacteria according to Bergey's manual of systematic bacteriology

Module II: Bacteria

Bacterial morphology, Ultra structure of bacteria, Bacterial nutrition and nutritional types - Photolithotrophs, chemolithotrophs, photoorganotrophs, and chemoorganotrophs. Bacterial Genetics: Organization and replication of genetic material in bacteria–bacterial chromosome, plasmid. Recombination in bacteria – conjugation, transformation and transduction.

Module III: Viruses

Nomenclature and classification of viruses, Properties, morphology (symmetry) and general account on different kinds of viruses. Viral genome. Structure of bacteriophage, TMV and HIV. Viral replication-Lytic and Lysogenic cycles. Sub viral particles - prions, viroids, virusoid.

Module IV: Culturing of Microorganisms

Methods for isolation of microorganisms, pure culture, culture media and methods, maintenance and preservation of cultures, Lyophilization, Culture collection centres, Solid state fermentation, bioreactors, immobilization

References

1. *Ananthanarayanan &J.Panicker, 2006. A textbook of Microbiology. Orient Longman pvt. Ltd.*
2. *Arora, D.R. & Arora, B. 2008. Text Book of Microbiology. CBS Publishers & Distributers, Delhi.*
3. *Chakraborty, P. A.2009. Text Book of Microbiology. New Central Book Agency.New Delhi.*
4. *Harma and Kanika.2009.Manual of Microbiology Tools &Techniques. Ane Books Pvt. Ltd. Delhi.*
5. *Ingraham, J. L. and Ingraham, C. A. 2000. Microbiology (2nd edn). Brooks/ColeThomson Learning, MA,USA.*
6. *L. M. Prescot. J. P. Harley and D. A. Klein. 2008. Microbiology (7thedn). McGraw Hill International,NJ, USA.*
7. *P. S. Abraham G and Francis G. 2008. Microbiology & Immunology Published by Zoological Society of Kerala.*
8. *T. Park., N. Kathelee and T. Arthur. 2002. Foundations of Microbiology. McGraw Hill Higher Education,NY.*
9. *Wheelis, Mark. 2010. Principles of Modern Microbiology. Jones and Bartlett Publishers,NY,USA*

IMSE203MM Ordinary Differential Equations, Probability and Statistics

Credits 3(3-1-0)

ModuleI: Ordinary Differential Equations

Exact differential equations and integrating factors (proof of theorem 2.1 excluded , separable equations and equations reducible to this form, linear equations and Bernoulli equations, special integrating factors and transformations. Orthogonal and oblique trajectories.

ModuleII: Basic Theory of Linear Differential Equations.

The homogeneous linear equation with constant coefficients. The method of undetermined coefficients, Variation of parameters, The Cauchy – Euler equation,

Module III: Power Series Solution About an Ordinary Point

solutions about singular points, the method of Frobenius , Bessel's equation and Bessel Functions, Differential operators and an operator method

Module IV:Random Variable and Probability Distributions

Definition and properties of random variables, discrete and continuous random variables, probability mass and density functions, distribution function. Mathematical Expectation,Special Distributions: Discrete uniform, Binomial, Negative Binomial, Geometric, hyper-geometric, Poisson, Exponential, Gamma, Normal distributions,Concepts of bivariate random variable: joint, marginal and conditional distributions, product moments, correlation, independence of random variables, bivariate normal

distribution, Covariance and Correlation Simple Linear Regression, Properties of the Least Squares Estimators.

Module V: Point Estimation
The Central Limit Theorem and Sampling distributions,the Method of Moments and the Method of Maximum Likelihood Estimation, Confidence Interval on the Mean of a Normal distribution- Known and Unknown Variance, Confidence Interval on the Variance and Standard Deviation of a Normal Distribution, A Large-Sample Confidence Interval for a Population Proportion

References:

1. *Shepley L. Ross - Differential Equations, 3rd ed., (Wiley India).*
2. *D. C. Montgomery & G.C. Runger, Applied Statistics and Probability for Engineers, John Wiley & Sons, Inc. 2005*
3. *A.H.Siddiqi & P. Manchanda – A First Course in Differential Equation with Applications (Macmillian)*
4. *G. F. Simmons-Differential equation with applications and historical notes(Tata Mc Graw Hill)*
5. *Freund, J.E., Mathematical Statistics, Pearson Education, 2002*
6. *Meyer, P.L., Introductory Probability and Statistical Appl., Oxford & IBH, 1970.*
7. *Arnold and Milton, Probability and Statistics, TMH, 2rd ed, 2007*

IMSC204CS Methodology of Programmimg using C

Credits 3(3-1-0)

ModuleI: Introduction to Programming,
Algorithms, Flowcharts, Types of Programming Methodologies, Introduction to C Programming - Selection and Repetition Statements.

Module II: Top-Down Design
Predefined Functions, Programmer-defined Function,Functions with Default Arguments,Call-By-Value and Call-By-Reference Parameters, Recursion.

ModuleIII: Arrays
Structures,Union: Multi-Dimensional Arrays, Structures - Member Accessing, Pointers to Structures, Structures and Functions, Arrays of Structures, Unions.

Module IV: Pointers and Strings
Arraysof Strings, String and Function, Strings and Structure, Strings and Pointers, Standard String Library Functions.

Module V: Files
Read, Write, Append contents to a File, Sequential and Random Search of Contents, Merging and Copying Files.

References

1. *Jens Gustedt, Modern C, ISBN 9781617295812, MManning.*
2. *Brian W Kernighan & Dennis Ritchie, "The C programming language", 2nd Edition, Prentice Hall*
3. *C Primer Plus, 6th Edition, Stephen Prata, Addison-Wesley Professional.*
4. *J. R. Hanly and E. B. Koffman, Problem Solving and Program Design in C, Pearson.*
5. *Programming and problem solving with C++: brief edition, N. Dale and C. Weems, Jones& Bartlett Learning.*

IMSC205ES Introduction to Environmental Sciences

Credits 3(3-1-0)

Module I: Introduction
Basics of Environmental science, Social and cultural construction of 'environment'; environmental thought from historical and contemporary perspective in light of the concepts of Gross Net Happiness and Aldo Leopold's Land Ethic.

Module II: Development and Environment
Developmental issues and related impacts such as ecological degradation; environmental pollution; development-induced displacement, resettlement, and rehabilitation: problems, concerns, and compensative mechanisms; discussion on Project Affected People (PAPs).
Production and consumption oriented approaches to environmental issues in Indian as well as global context; impact of industry and technology on environment; urban sprawl, traffic

congestion and social-economic problems; conflict between economic and environmental interests.Historical case studies of environmental crisis

Module III: History of Environment Protection
Origin of conservation NGOs like WWF, UNEP etc., Silent spring, Our common future. International initiatives for environmental protection – Ramsar convention, Stokholm conference, Rio, Rio+10, Rio+20, Conferences for reducing green house gases and Ozone depleting substances, COP

Module IV: Environment and Social Inequalities
Inequalities of race, class, gender, region, and nation-state in access to healthy and safe environments; history and politics surrounding environmental, ecological and social justice; environmental ethics, issues and possible solutions.

Module V: Community Participation
State, corporate, civil society, community, and individual-level initiatives to ensure sustainable development; case studies of environmental movements (Appiko Movement, Chipko Movement, Silent valley, Narmada BachaoAndolan); corporate responsibility movement; appropriate technology movement; environmental groups and movements, citizen groups; role played by NGOs; environmental education and awareness.

Reference

1. *Chokkan, K.B., Pandya, H. & Raghunathan, H. (eds). 2004. Understanding Environment. Sagar Publication India Pvt. Ltd., New Delhi.*
2. *Elliot, D. 2003. Energy, Society & Environment, Technology for a Sustainable Future. Routledge Press.*
3. *Guha, R. 1989. Ecological change and peasant resistance in the Himalaya. Unquiet Woods, Oxford University Press, Delhi.*
4. *National Research Council (NRC). 1996. Linking Science and Technology to Society's Environmental Goals. National Academy Press.*

IMSC206LE English Language-2

Credits 2(2-1-0)

Evolution of the Philosophy of Science: Literary Perspectives

Module I:**Essays**

- C.V.Raman – The Scientific Outlook
- Stephen Hawking – Our Picture of the Universe
- Carl Sagan – Our Ancestors
- Aldous Huxley – Literature and Science
- William Rueckert – Literature and Ecology

Module II: Short Stories

- Ambrose Bierce – Moxon's Master
- Jayant Narlikar – The Comet

Module III: Drama and Poetry

- Neil Grant – The Last War
- K. Satchidanandan–Hiroshima Remembered
- Peter Porter – Your Attention Please
- Hilaire Belloc – The Microbe

Required Reading:

K.Sujatha and SobhanaKurien – *Evolution of the Philosophy of Science: Literary Perspectives*, Department of Printing and Publishing Mahatma Gandhi University Kottayam, 2015

IMSC207CH Physical Chemistry Lab-1

Credit 1(0-0-3)

1. Mixed melting point determination:
    a. Urea-Cinnamic acid mixture of (1:4, 1:1, 4:1)compositions
    b. Decolorisation and Crystallization using Charcoal
    c. Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration.
2. Crystallization of the any three of following compounds
    a. Phthalic acid from hot water (using fluted filter paper and stemless funnel)
    b. Acetanilide from boiling water
    c. Naphthalene from ethanol
    d. Benzoic acid from water
3. Physical chemistry experiments
    a. Conductometric titration of strong acid x strong base
    b. To study the saponification of ethyl acetate conductometrically.
    c. To determine the Ionisation constant of a weak acid conducto metrically.
    d. Preparation of acidic / alkaline buffer solutions and measure the pH.
    e. Potentiometric titration of strong acid with strong base.
    f. To determine the specific rotation of a given optically active compound
    g. Determination of viscosity of various liquids using Ostwald's viscometer.

References:

1. *Vogel's Textbook of Quantitative Chemistry.*
2. *Findley's Practical Physical Chemistry, B. P. Levitt, Longman.*
3. *Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal*

IMSC207PH General Physics Lab-2

Credit 1(0-0-3)

1. Cantilever – Scale and telescope – Determination of Young's modulus
2. Cantilever – Pin and Microscope – Determination of Young's modulus
3. Vertical oscillations of a spring – Determination of Young's modulus
4. One dimensional elastic collision – Hanging sphere method – Law of conservation of energy and momentum
5. Static Torsion – Determination of rigidity modulus
6. Flywheel – Determination of moment of inertia
7. Constant pressure head – Determination of viscosity of a liquid
8. Variable pressure head – Determination of viscosity of a liquid
9. Stokes's method – Determination of viscosity of a liquid
10. Capillary rise method – Determination of surface tension
11. Quincke's method – Determination of surface tension
12. Vertical oscillations of a spring with mass.

Reference books

1. *Practical Physics, P R Sasikumar Eastern Eco. Ed.*
2. *Advance level Practical Physics IV Ed., Nelkon and J M Ogborn*
3. *Advance course in Practical physics, D Chathopathyaya*
4. *Practical Physics,C L Arora*
5. *Digital fundamentals,Thomas L Floyed*
6. *A course of experiments with He-Ne Laser, R S Sirohi*
7. *Laboratory manael for introductory Electronic experiments, L K Maheswari & Nm S Anand*

IMSC207LS Microbiology Lab-1

Credit 1(0-0-3)

1. Preparation and sterilization of various microbial culture media and inoculation-liquid media-nutrient broth, peptone water, Solid media-Nutrient Agar, Mac Conkey' Agar, Semi solid agar
2. Culturing of microorganism - broth culture, pure culture, culture techniques- streak plate, pour plate culture, lawn culture, stab culture
3. Isolation of colonies and preservation of bacterial culture
4. Laboratory Record

References

1. *Microbiology: A Laboratory Manual (7th Edition) by James Cappuccino , Natalie Sherman*
2. *Laboratory Experiments in Microbiology (12th Edn) by Ted R. Johnson and Christine L. Case*
3. *Laboratory Manual of Microbiology and Biotechnology by Aneja K.R. Medtec, 2014*

IMSC208ES Environmental Lab- Field practical

Credit 1(0-0-3)

Techniques and procedures in

1. Reading topographical maps and locating oneself in the field,
2. Identifying common minerals and rocks in the field
3. Identification of common rock structures in the field
4. Quarry-face mapping,
5. Preparation of geological reports and maps.
6. Stream hydrology
7. River morphology

Forest ecosystems – structure and ecology
Weather monitoring – wind directions, rain guage, Hygrometer
Flood level monitoring
Preliminary assessment of landslides

References:

1. *Basic Geological Mapping, Barnes J.W., Open University Press*
2. *Manual of Field Geology, Robert R. Compton, John Wiley andSons*
3. *Guide To Field Geology, S.M. Mathur , PHI Learning Pvt. Ltd*
4. *Ecology and Environment, PD Sharma, Rastogi Publications*

IMSC209CS C Programming Lab

Credit 1 (0-0-3)

Given the problem statement, students are required to formulate problem, develop flowchart/algorithm, write code, execute and test it based on the theory course "Methodology of Programmimg using C". Students should be given assignments on following :

1. To learn elementary techniques involving arithmetic operators and mathematical expressions, appropriate use of selection (if, switch, conditional operators) and control structures, functions implementing programs.
2. To execute programs to learn the use of strings and string handling operations, Arrays, Structures and Union, pointers.
3. To execute programs using files for data input and output and programs for search algorithms.

References

1. *Jens Gustedt, Modern C, ISBN 9781617295812, MManning.*
2. *Brian W Kernighan & Dennis Ritchie, "The C programming language", 2nd Edition, Prentice Hall*
3. *C Primer Plus, 6th Edition, Stephen Prata, Addison-Wesley Professional.*
4. *J. R. Hanly and E. B. Koffman, Problem Solving and Program Design in C, Pearson.*
5. *Programming and problem solving with C++: brief edition, N. Dale and C. Weems, Jones& Bartlett Learning.*

SEMESTER III

IMSE301CH Organic Chemistry-1

Credits 3(3-1-0)

Module I: Basic Organic Synthesis and Principles

Alkanes: preparation by reduction of alkyl halides, Wurtz reaction and Kolbe's electrolytic methods with mechanism; Alkenes: preparation by dehydration of alcohols, dehydrohalogenation of alkylhalides, dehalogenation of vicdihalides and by Kolbe's electrolytic method. Alkynes: Preparation by dehydrohalogenation of vic-dihalides and gem-dihalides, dehalogenation of tetrahalides.Reactions:addition reactions with hydrogen, halogens, hydrogen halide (markownikoffs rule, peroxide effect), hydroboration, ozonolysis, hydroxylation with KMnO4, allylic substitution by NBS.

Module II: Elimination & Substitutions Reactions

SN1 and, SN2 reaction mechanism: effects of structure, substrate, solvent, nucleophile and leaving groups. Mechanisms of E1 and E2 reactions, Hoffmann and Saytzeffs rules cis and trans eliminations, Elimination Vs substitution. Addition reactions.

Module III: Aromatic Compounds & Aromaticity

Aromatic hydrocarbons and aromaticity, resonance in benzene, Huckel's (4n+2) rule and its simple applications. Acidic character of phenols - explanation on the basis of resonance stabilization. Electrophilic substitution reactions in aromatic compounds. ortho/para/meta directive influence with examples.

Module IV: Alcohols and Phenols

Methods to distinguish between Primary, secondary and tertiary alcohols (Lucas, Victor Meyer's and oxidation method). Preparation of monohydric alcohols from carbonyl compounds using Grignard reagents, reduction of aldehydes, ketones, carboxylic acids and esters,Rosenmund's reduction, Hydrogen bonding, Acidic nature, Reactions of alcohols.Dihydric alcohols: methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)4 and HIO4] and pinacol-pinacolone rearrangement. Trihydric alcohols: methods of formation, reactions of glycerol.

Nomenclature, structure and bonding of phenols, Preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion, Reactions of phenols - electrophillic aromatic substitution, acylation and carboxylation, Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch, Lederer-Manasse and Reimer-Tiemann reaction.

References:

1. *Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.*
2. *Organic Chemistry by Morrison Boyd*
3. *Organic Chemistry by Finar*
4. *Organic Chemistry, Morrison and Boyd, Prentice Hall*
5. *Organic Chemistry, J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University Press, USA*

IMSE301PH Waves and Oscillations

Credits 3 (3-1-0)

Module l: Harmonic Oscillator

Periodic Motion, Simple Harmonic Motion and Harmonic Oscillator, Energy of a Harmonic Oscillator, Examples of Harmonic Oscillator, Anharmonic Oscillator, Composition of Two Simple Harmonic Motions of Equal Periods in a Straight Line, Composition of Two Rectangular Simple Harmonic Motions of Equal Periods: Lissajous Figures

Damping Force, Damped Harmonic Oscillator, Examples of Damped Harmonic Oscillator, Power Dissipation, Quality Factor, Forced Harmonic Oscillator Forced oscillations and Resonance; Simple coupled oscillators

Module ll: Waves

Waves-classifications-- superposition of waves- theory of beats- Wave Motion, General Equation of Wave Motion, Plane Progressive Harmonic Wave,Energy Density for a Plane Progressive Wave, Traveling waves, Superposition principle, Wave speed, Power and intensity in wave motion, Interference

of sound waves, Stationary waves, Beats, Waves on strings and surfaces, Audible, ultrasonic and infrasonic waves, Propagation and speed of longitudinal waves, Vibrating systems and sources of sound, Musical instruments, The Doppler effect, Shock waves, Velocity of sound and its measurement, factors affecting the speed of sound Nature and propagation of light

Module lll: Optical Instruments
Images, Defects of images, Spherical and Chromatic aberrations, Achromatism of two thin lenses separated by a distance, Optical instruments (Microscopes and Telescopes), Velocity of light and its measurement.

Module IV: Acoustics
Intensity of Sound- Decibel and Bel, Loudness of Sound, Noise Pollution, Ultrasonics: Production of Ultrasonic Waves- Piezo Electric Crystal Method, Determination of Velocity of Ultrasonic Waves in a Liquid - Acoustic Grating, Application of Ultrasonic Waves,

References

1. *Fundamentals of Physics, Resnick, Halliday and Walker, 6th edition, Wiley*
2. *University Physics, Sears and Zemansky, 10th edition, Addison – Wesley series*
3. *Fundamentals of Optics, Jenkins and White*
4. *Light, K. G. Mazumdar*
5. *Geometrical and Physical Optics, P. K. Chakraborty*
6. *Properties of Matter and Acoustics by R.Murugeshan & Kiruthiga Sivaprasath 2005*

IMSE302LS Plant Diversity

Credits 3(3-1-0)

Module I: Systematic Botany
Aim, scope and significance, Uninominal, Binomial, & Trinomial nomenclature, ICN

Module II: General Characters of He Following Groups of Algae
Classification proposed by Fritsch; 1. Cyanophyceae, 2. Chlorophyceae, 3. Xanthophyceae, 4. Bacillariophyceae, 5. Phaeophyceae6. Rhodophyceae

Module III:Mycology and Lichenology
Introduction, structure, reproduction, life cycle and evolutionary trends in fungi. Classification based on Ainsworth (1973). Reproductive structures and life history of the following groups;1. Myxomycotina,2. Mastigomycotina, 3. Zygomycotina, 4. Ascomycotina, 5. Basidiomycotina, 6. Deuteromycotina.
General account on economic and ecological importance of lichen, Structure and reproduction.

Module IV: Bryophyta
Introduction, General Characters, classification, evolution and alternation ofgeneration in bryophytes.

ModuleV: Pteridophytes
Introduction, General Characters, classification, evolution and alternation ofgeneration in pteridophytes.

Module VI: Gymnosperms
Introduction, General Characters, classification, evolution and development of seedhabit in gymnosperms.

Module VII: Angiosperm Morphology and Systematic Botany
Morphology of flower, inflorescence and fruits. Herbarium technique, Herbaria, Botanical gardens and BSI. Bentham and Hookers system of classification.

References

1. *Alexopoulos C. J., M Blackwell, C. W. Mims. Introductory Mycology (IV Edn).*
2. *Beddome C. R. H. 1970. Ferns of south India. Today & Tommorrows Publ.*
3. *Bhatnagar S. P., Moitra A. 2000. Gymnosperms. New Age International Ltd.*
4. *Biswas C. The Gymnosperms. Today and Tomorrows print.*
5. *Chapman V. J. 1962. The Algae. Macmillan & Co. Ltd*
6. *Chopra R. N., P. K. Kumar (1988). Biology of Bryophytes. Wiley Eastern Ltd.*
7. *Dube H. C. 1983. An introduction to fungi. Vikas Publ. New Delhi*
8. *Fritsch F. E. (Vol. I-II) 1977. The structure and reproduction of Algae. Cambridge Univ. Press.*

9. *Gilbert M. Smith 1951. Manual of Phycology.*
10. *Gilbert M. Smith 1971. Cryptogamic Botany (Vol. 1): Algae & Fungi. Tata McGraw Hill Edition.*
11. *Hale M. E. The biology of lichens.*
12. *H. C. Bold, M. J. Wynne 1978. Introduction to Algae: Structure and reproduction. Prentice Hall.*
13. *Rashid A. 1976. An introduction to Pteridophytes. Vikas Publishing House.*
14. *Rashid A. 1981. An Introduction to Bryophyta. Vikas publishing house Pvt. Ltd.*
15. *Takhtajan A. L. 1997. Diversity and Classification of Flowering Plants. Columbia Univ. Press.*
16. *Wendy B. Zomlefer 2006. Guide to Flowering Plant Families. Overseas Press India, Private Ltd.*

IMSE302MM Calculus and Vector Calculus

Credits 3(3-1-0)

Module I: Application of Derivatives
Extreme values of Functions – The Mean Value Theorem – Monotonic Functions and the First Derivative Test – Concavity and Curve Sketching –Anti Derivatives.

ModuleII: Partial Derivatives
Functions of Several variables, Limits and continuity, Partial Derivatives, The Chain Rule, Directional Derivatives and Gradient Vector, tangent Planes and Differentials, Extreme Values and Saddle points.

ModuleIII:The Definite Integral
The Fundamental Theorem of Calculus – Indefinite Integrals and the Substitution Rule – Substitution and Area between Curves.

ModuleIV:Application of Definite Integrals and Multiple integrals
Volumes by Slicing and Rotation about an Axis – Volumes by Cylindrical Shells – Lengths of Plane Curves – Moments and Centre of Mass-Areas of Surface of Revolution and the Theorems of Pappus. Double integrals, Double integrals in Polar form, Triple Integrals, Triple Integrals in Cylindrical and Spherical Coordinates.

ModuleV: Integration of Vector Fields
Line Integrals, Vector Fields, work, Circulation, Flex, Path independence, Conservative Fields, Greens Theorem in Plane, Surface Integrals, Stokes theorem, Divergence theorem.

References:
1. ***Text:*** *Thomas' Calculus Maurice D Weir, J. Hass, F. R Giordano 11th Edition (Pearson)*
2. *A quick review of the basic concepts of Differentiation and the Derivative as a Function. Relevant sections of Chapter 3 Tom M. Apostol, Calculus Volume 2, John Wiley & Sons, Second edition, 2007.*
3. *Murray R Spiegel, Theory and problems of vector analysis, Schaum's outline series, McGraw-Hill Book Compnay 1974.*

IMSE303CS Computer Organization and Architecture

Credits 3(3-1-0)

Module I: Basic Computer Organization and Design
Operational concepts, Instruction codes, Computer Registers, Computer Instructions, Timing & Control, Instruction Cycles, Memory locations and addresses, Memory Reference Instruction, Input - Output & Interrupts, Bus organization, Complete Computer Description & Design of Basic Computer,

Module II:Processor and Control Unit
Hardwired vs. Micro programmed Control Unit, General Register Organization, Stack Organization, Addressing modes, Instruction Classification, Program control.

ModuleIII: Memory Organization
Main Memory, Memory Hierarchy, Processor vs. Memory Speed, High-Speed Memories, Cache Memory, Associative Memory, Interleave, Virtual Memory, Memory Management, Auxiliary memory, Memory mapping Techniques.

Module IV:I/O Systems
Peripheral Devices, I/O Interface, Data Transfer Schemes, Program Control, Interrupt, DMA Transfer, I/O Processor.

Module V: Parallel Architectures

Introduction to parallel processing, Pipeline computers, Multi processing systems, Instruction-level-parallelism, Parallel processing challenges, Flynn's classification , Hardware multithreading, Multicore processors, Pipelining and Vector processing, Array Processors.

References

1. *M.Morris Mano, Computer Systems Architecture, Third Edition, Pearson Education*
2. *Carl Hamacher, Computer Organization, Fifth Edition, Tata McGraw Hill.*
3. *John P Hayes , Computer Architecture & Organization, Mc Graw Hill.*
4. *David A. Patterson and John L. Hennessey, Computer Organization and Design, Fifth edition, Morgan Kauffman / Elsevier, 2014.*
5. *John L. Hennessy, David A. Patterson, Computer Architecture: A Quantitative Approach, 4th Edition.*
6. *William Stallings, Computer Organization and Architecture , Seventh Edition, Pearson Education*
7. *Kai Hwang and F A Briggs, Computer Architecture and parallel processing, McGraw Hills.*

IMSE303ES Physical Systems of Environment

Credits 3(3-1-0)

ModuleI: History of the Earth

Formation of Solar system and planetary differentiation; formation of the Earth: formation and composition of core, mantle, crust, atmosphere and hydrosphere; chemical composition of theEarth; geological time scale and major changes on the Earth's with time; Holocene and the emergence of humans, role of humans in shaping landscapes; development of cultural landscapes.

Module II: Earth system processes

Movement of lithospheric plates; mantle convection and plate tectonics, major plates and hot spots, plate boundaries; sea floor spread; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; origin of the main geomagnetic field; continental drift, Pangaea and present-day continents

Module III: Earth surface processes

Atmosphere: Structure and composition of earth's atmosphere, atmospheric circulation; interfaces: atmosphere–ocean interface, atmosphere–land interface, ocean–land interface;monsoons; evolution of monsoon in Indian subcontinent, land surface processes: Aeolian, fluvial and glacial processes, Weathering, erosional and depositional landscapes; coastal processes.

Module IV:Minerals and rocks

Minerals;atomic structure, physical properties, major rock-forming minerals; Rocks-classification, form, texture and mineralogy of common Igneous, Metamorphic, Sedimentary, Rock cycle; Petrogenetic processes – magmatism and related processes – deposition and lithification of sediments – metamorphic processes; Rock deformation: folds, faults and joints

References

1. *Bridge, J., &Demicco, R. 2008. Earth Surface Processes, Landforms & Sediment deposits. Cambridge University Press.*
2. *Duff, P. M. D., & Duff, D. (Eds.). 1993. Holmes' Principles of Physical Geology. Taylor & Francis.*
3. *Gupta, A. K., Anderson, D. M., &Overpeck, J. T. 2003. Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean. Nature 421: 354-357.*
4. *Keller, E.A. 2011. Introduction to Environmental Geology (5th edition). Pearson Prentice Hall.*
5. *Leeder, M., Arlucea, M.P. 2005. Physical Processes in Earth & Environmental Sciences. Blackwell Publishing.*
6. *Pelletier, J. D. 2008. Quantitative Modeling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago.*

- **IMSE304LM/H/S/A/F Second Language Elective-2** (2 credits)
  (Malayalam/Hindi/Sanskrit/Arabic/French)

IMSE305CH Organic Chemistry Lab-1

Credit 1(0-0-3)

1. Crystallization and decolorisation of impure naphthalene (100 g of naphthalene mixed with 0.3 g Congo Red using 1 g decolorizing carbone) from ethanol
2. Distillation of
    a. ethanol-water mixture using water condenser Distillation
    b. Distillation of nitrobenzene and aniline using air condenser
3. Thin Layer Chromatography: Determination of Rf values and identification of organic compounds.
    a. Separation of green leaf pigments (spinach leaves may be used).
    b. Preparation and separation of 2,4-dinotrophenylhydrazones of acetone, 2-butanone, hexan-2- and 3-one using toluene and light petroleum (40:60).
4. Organic chemistry experiments
    a. Element detection and Functional group determination (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and aniline) in simple organic compounds.

References:

1. *Vogels Textbook of Practical Organic Chemistry*
2. *Experimental Organic Chemistry Vol 1 and 2, P R Singh, D S gupta, K S Bajpai, Tata McGraw Hill*

IMSE305PH Sound and Optics Lab

Credit 1 (0-0-3)

1. Coupled oscillator – measurement of normal mode frequencies
2. Kundt's tube – determination of velocity of sound in air
3. Sonometer – resonance modes of a stretched string & velocity of wave propagation
4. Brewster angle method – measurement of refractive index of dielectric material
5. Fresnel biprism – determination of wavelength of light by interference
6. Newton's rings – determination of radius of curvature of a lens
7. Fabry – perot interferometer – measurement of air gap thickness
8. Diffraction grating – determination of wavelengths of mercury vapor lamp.
9. Liquid Lens-Determination of refractive index of liquid
10. Spectrometer-Determination of refractive index of liquid and material of the prism
11. Newton's Ring- Determination of wavelength of sodium light.

References:

1. *Properties of Matter,D S Mathur*
2. *Practical Physics, P R Sasikumar Eastern Eco. Ed.*
3. *Advance level Practical Physics IV Ed., Nelkon and J M Ogborn*
4. *Advance course in Practical physics, D Chathopathyaya*
5. *Practical Physics,C L Arora*
6. *Electronics Lab Manuel , K A Navas*
7. *Digital fundamentals,Thomas L Floyed*
8. *A course of experiments with He-Ne Laser, R S Sirohi*
9. *Laboratory manael for introductory Electronic experiments, L K Maheswari & Nm S Anand*
10. *Optics, N Subramanyan, Brij Lal 7 Avadhanalu*

IMSE305CS Internet Technologies Lab

Credit 1 (0-0-3)

Given the problem statement, students are required to formulate problem, develop code, executeand test it. Students should be given programming assignments on following

- User Interface Design: HTML Editors, Image maps in a website, CSS and DHTML, XML and XHTML document construction, Display Alert, Confirm and Prompt Dialog Boxes, Web applications using Java Script, Java Beans API.
- Interaction with Database: SQL, MySQL, JDBC
- Server side scripting using AJAX and JQUERY and for creating dynamic webpages using HTML5.
- Internet Telephony: VoIP, Streaming media, Codec and Plugins, Search Engine and Web Crawler.

References

1. *Chris Bates, Web Programming Building Internet Applications, Wiley publications.*
2. *Joel Sklar, Principles of Web Design, Vikas Publications.*
3. *Dr.Sipi Dubey, Computer Concepts and Web technology, Dreamtech Press.*
4. *Ralph Moseley, Web Technology, Wiley Precise Textbook Series.*
5. *V K Jain, Advanced programming in Web Design, Cybertech Publications.*

IMSE306LS Microbiology Lab-2

Credit 1 (0-0-3)

1. Identification of microorganisms - Differential staining of bacteria using Gram stain,
2. Oxidase test, Catalase test, Oxidation/fermentation (O/F) test
3. Isolation of microbes from soil: Serial dilution - pour plate/spread plate method and enumeration of microorganisms.
4. Antibacterial assay - disc diffusion / agar well method.
5. Laboratory Record

References

1. *Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation. Aneja K. R. 1996. Wishwa Prakasan, Delhi.*
2. *Practical Microbiology, R.C Dubey, D.K Maheshwari, S Chand and Company, New Delhi.*
3. *Microbiology: A Laboratory Manual (7th Edition) by James Cappuccino , Natalie Sherman*

IMSE306CS Web Programming Lab

Credit 1 (0-0-3)

PHP and MySQL

Given the problem statement, students are required to formulate problem, develop code, execute and test it. Students should be given programming assignments on following :

- Configuring and Installation-Apache and PHP, MySQL, Develop HTMLform with PHP, PHP pages using PHP tags, setting and using Session and Cookie, using File and Directories.
- Creating and managing Databases using MySQL, Input, Output and Edit Databases, Manipulating and Creating Images with PHP, Validation
- Develop Applications/Projects using PHP5 (LAMP, WAMP may also be used).

References

1. *Chris Bates, Web Programming Building Internet Applications, Wiley publications.*
2. *Larry Ullman, PHP and MySQL For Dynamic Web Sites, 4th Edition,Pearson,.*
3. *Steven M.Schafar, HTML, CSS, Javascript, Perl, Python & PHP, Wiley Publication.*
4. *ElizebethNaramrore, Jaison Garner, Beginning PHP5, Apache and MySQL.*
5. *H M Deitel, P J Deitel&A B Goldberg, Internet and Worldwide Web Programming: How to Program, 3/e, Pearson Education.*

- **IMSO307GE Open course-**Credits 4(4-0-0)

- **IMSE308SMSeminar-**Credits 1(0-2-0)

Student has to present seminar(s) based on the assigned topic

- **IMSE309VVComprehensive Viva-Voce-**Credits 2(0-0-0)

  Mid graduate level course viva shall be conducted at the end of the semester based on the courses learned upto third semester.

SEMSESTER IV

IMSE401CH InorganicChemistry-1

Credits 3 (3-1-0)

Module I: Chemistry of Representative Elements

Comparative study of s and p block elements ,diagonal relationships - Inert pair effect. Ionic compounds: BornLande equation (No derivation),Born-Haber cycle and its applications, Lewis acidity of boron halides - Preparation, properties, structure and uses of Diborane, Boric acid, Borazine and Boron nitride . Structures of oxides of N and P, oxy acids of N and P, Structure and acidic strength of oxy and peroxy acids of sulphur, oxy acids of chlorine. Preparation, properties and uses of ammonia, nitric acid, ozone, hydrogen peroxide, sulphuric acid and hydrochloric acid. Chemical properties of the noble gases, chemistry of xenon, structure and bonding of xenon compounds.

Module II: Transition and Inner Transition Elements

Characteristic properties of d- and f- block elements,General group trends with special reference to electronic configuration, colour, and variablevalency, ability to form complexes, magnetic and catalytic properties, non-stoichiometric compounds, complex formation and alloy formation. Chemistry of first transition series in various oxidation states. Explanation of metallic properties of transition metals based on theories of Metallic Bonding- Free electron theory, valence bond theory and band theory

Lanthanides: Occurrence of lanthanides ,Isolation of lanthanides from monazite sand – Separation by ion exchange method. Lanthanide contraction: Causes and consequences. Industrial importance of lanthanides. Actinides: Electronic configuration and general characteristics

Module III:Bioinorganic Chemistry

Metal ions in biological system -Trace and bulk metal ions.General aspects of chemistry of dioxygen Hemoglobin and Myoglobin , Chlorophyll and photosynthesis, Nitrogen fixation and vitamin B12 - Sodium-potassium pump- Biochemistry of Ca, Zn and Co- Toxicity of metal ions (Pb, Hg and As). Anticancer drugs: Cis-platin, oxaliplatin, carboplatin and auranofin - Structure and significance.

Module IV: Chemistry of Non-aqueous Solvents:

Non-aqueous Solvents: Classification – General properties – Self ionization and leveling effect Reactions in non-aqueous solvents with reference to liquid NH_3, H_2SO_4, liquid HF, HSO_3F, liquid SO_2. N_2O_4, PCl_5, BrF_3 super acids, ionic liquid: molten salts solvent systems, ionic liquid at ambient temperature; supercritical fluids: properties of supercritical fluids and their uses as solvents,

Module V: Nuclear chemistry

Nuclear forces, Radioactivity: Characteristics of radioactive decay, Decay kinetics, types of decay, α, β, γ- emissions, artificial radioactivity. Nuclear fission and fusion; Nuclear Reactors: Classification of reactors, reactor power, and application of radioactivity,Decay series -group displacement law - Isotopes: Detection - Aston's mass spectrograph -Separation of isotopes -Application of radioactive isotopes -^{14}C dating -Radio diagnosis and radiotherapy, nuclear waste Management

References:

1. *Basic Inorganic Chemistry by F. A. Cotton & Wilkinson, John Wiley*
2. *Inorganic Chemistry by J. E. Huhey, Harpes& Row*
3. *Comprehensive Co-ordination Chemistry by G. Wilkinson, et.al.Pergamon*
4. *Concise Inorganic Chemistry by J D Lee.*
5. *B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry*
6. *D. F. Shriver, P. W. Atkins, Inorganic Chemistry*

IMSE401PH Classical Mechanics-1

Credits 3 (3-1-0)

Module I:Fundamentals of Newtonian Mechanics

Frames of reference- Cartesian, plane polar, cylindrical and spherical polar co-ordinates - Newton’s laws of motion - first, second and third laws - Inertial frames and non-inertial frames - Mechanics of a particle - conservation of linear momentum, angular momentum and torque, conservation of angular momentum, work done by a force, conservative force, conservation of energy. Motion under a constant force -

Motion under Time-dependent force - Motion under velocity dependent force - Motion of charged particles in magnetic fields.

Module ll: Lagrangian formulations
Constraints, Generalized co-ordinates, Principle of virtual work, D'Alembert's principle, Lagrange's equations, Kinetic energy in generalized co-ordinates, Generalized momentum, Cyclic co-ordinates, Conservation laws and symmetry properties-Hamiltonian of a system

Module III: Lagrange Equation
Constraints - Holonomic constraints, Non-holonomic constraints, Scleronomous and Rheonomous constraints. Generalized coordinates – Degrees of freedom, Configuration space, Generalised velocities and generalized momenta. Concept of Lagrangian. Application of Lagrange's equation for calculation of Lagrangian and derivation of equation of motion for a simple physical system (Compound pendulum, linear harmonic oscillator). Lagrange's equations - Velocity dependent potential

Module lV: Central Force Problem
Motion under central force : Central force and its examples. Reduction of motion of two bodies to the motion of single body by introducing the concept of reduced mass. Lagrangian of a particle under central force. Differential equation of orbit of a particle under central force, Kepler's laws planetary motion and its deduction.

Module V: Hamiltonian Formulation
Hamiltonian formulation: Concepts of phase space, Principle of variation, Deduction of Hamiltion's canonical equations from variational principle. Concept of Hamiltonian and its physical interpretation. Deduction of Hamiltion's principle from D' Alemberts principle, Basic idea of Hamiltionian in quantum mechanics, Hamiltonian of simple pendulum.

Text and Reference Books

1. *Classical Mechanics -H. Goldstein*
2. *Classical Mechanics -N. C Rana & P. S. Joag*
3. *Classical Mechanics - G. Aruldhas*
4. *Chaotic Dynamics - G.L. Baker & J.P. Gollub*
5. *Mechanics - Landau - Lifshitz*
6. *Classical Mechanics - R. Douglas Gregory*
7. *Deterministic Chaos - N .Kumar, University Press*
8. *Classical mechanics - Takwala and Puranik*

IMSE401CS Operating Systems

Credits 3 (3-1-0)

Module I: Introduction
History and Evolution of OS, Basic OS functions, Resource Abstraction, Types of Operating Systems– Multiprogramming, Batch, Time Sharing Systems; Operating Systems for Personal Computers, Workstations and Hand-held Devices, Real time Systems, Operating System Services.

Module II: Process
Basic Concepts, Processor and User Modes, Kernels, System Calls and System Programs, System View of the Process and Resources, Process Abstraction, Process Hierarchy, Threads, Threading Issues, Thread Libraries; Process Scheduling, Non-Pre-emptive and Pre- emptive Scheduling Algorithms.

Module III: Process Management and Synchronization
Concurrent and Dependent Processes, The Critical Section problem, Semaphores, Methods for Inter-process Communication, Classical Problems of Synchronization, Monitors. Deadlocks: Deadlock Characterization, Methods of handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

Module IV:Memory Management
Physical and Virtual Address Space, Memory Allocation Strategies– Fixed and Variable Partitions , Swapping, Contiguous memory allocation, Paging, Segmentation. Virtual Memory Management-Demand paging, Page Replacement.

Module V: Storage and I/O Management

File Concepts, Access Methods, Directory structure, File System Structure, File Allocation Methods, Free Space Management, Disk Scheduling.

References:

1. *A Silberschatz, P.B. Galvin, G. Gagne, Operating Systems Concepts, 8th Edition, John Wiley Publications.*
2. *William Stallings , Operating Systems, Prentice Hall of India, Pearson*
3. *William Stallings, Operating Systems: Internals and Design Principles, 7th Ed., Prentice-Hall, 2011.*
4. *A.S. Tanenbaum, Modern Operating Systems, Pearson Education .*
5. *M. Milenkovic, Operating Systems- Concepts and design, Tata McGraw Hill*

IMSE402LS Animal Diversity

Credits 3 (3-1-0)

Module I: Animal Taxonomy

Brief history, Concepts and definition, Importance of classification, International Code of Zoological Nomenclature (ICZN), Importance principles of ICZN, Five Kingdom Classification.

Module II: Animal Body Oganization

Symmetry - Asymmetry, Spherical, Radial, Biradial and Bilateral. Coelom–Acoelomates, Pseudocoelomates and Eucoelomates, Schizocoelom and Enterocoelom, Protostomia and Deuterostomia.

Modue III: Kingdom Protita

Introduction, general characters, classification with brief account on examples of each phylum. Study of important human Protist pathogens.

Module IV: Kingdom Animalia – Non Chordata(Only brief account on examples)

Outline classification of Kingdom Animalia. Three branches – Mesozoa, parazoa, Eumetazoa.

Phylum Porifera – Salient features, Classification upto classes, Class I- Calcarea. Eg. Sycon., Class II – Hexactinellida . Eg. Euplectella., Class III – Demospongia Eg. Cliona.

Phylum Coelenterata (Cnidaria) - Salient features, Classification upto classes., Class I - Hydrozoa Eg. Halistemma., Class II – Scyphozoa Eg. Rhizostoma., Class III- Anthozoa Eg. Fungia. Polymorphism in Coelenterates.

Phylum Ctenophora - Salient features, Eg. Pleurobrachia.

Phylum Platyhelminthes - Salient features, Classification upto classes., Class I -Turbellaria. Eg. Planaria., Class II -Trematoda Eg. Fasciola, Class III- Cestoda Eg. Taenia saginata.

Phylum Nematoda - Salient features, Class phasmidia Eg. Enterobius, Ascaris, Class Aphasmidia Eg. Trichinella, Human Pathogenic nematodes.

Phylum Annelida - Salient features, Classification upto classes., Class IArchiannelida Eg. Polygordius., Class II-Polychaeta Eg. Chaetopterus., ClassIIIOligochaeta Eg. Megascolex.,Class IV - Hirudinomorpha Eg. Hirudinaria

Phylum Arthropoda - Salient features, Classification upto classes.

1. Sub Phylum - Trilobitomorpha Class - Trilobita

2. Sub Phylum- Mandibulata, Class I – Crustacea Eg. Sacculina., Class IIChilopoda Eg. Centipede (Scolopendra)., Class III – Symphyla Eg. Scutigerella.,

Class IV – Diplopoda Eg. Millipede (Spirostreptus)., Class V - Insecta Eg. Dragon fly., Class VI – Pauropoda Eg. Pauropus

3. Sub Phylum - Chelicerata., Class - Merostomata Eg. Limulus., Class II –Arachnida Eg. Scorpion

General Topics - Arthropods as Vectors, Beneficial Insects.

Phylum Mollusca - Salient features, Classification upto classes., Class IMonoplacophora Eg. Neopilina., Class II- Amphineura Eg. Chiton., Class IIIGastropoda Eg. Aplysia., Class IV- Scaphopoda Eg. Dentalium., Class V- Pelecypoda, Eg. Pinctada., Class VI- Cephalopoda Eg. Sepia

Phylum Echinodermata - Salient features, Classification upto classes., Class IAsteroidea Eg. Astropecten., Class II- Ophiuroidea Eg. Ophiothrix., Class III- Echinoidea Eg. Echinus, Class IV- Holothuroidea Eg. Holothuria., Class V –Crinoidea Eg. Antedon

Minor Phyla - 1. Chaetognatha Eg. Sagitta., 2. Sipunculida Eg. Sipunculus.,3. Rotifera Eg. Brachionus

Phylum Hemichordata - Salient features, Eg. Balanoglossus

Module V: Kingdom Animalia – Chordata

Phylum Chordata – Salient features of Chordates.Sub phylum :Urochordata Class I Larvacea Eg. Oikopleura., Class II Ascidiacea Eg:Ascidia, Class III Thaliacea Eg: Doliolum

Sub phylum: Cephalochordata Eg: Amphioxus,Sub phylum: Vertebrata
Division 1 – Agnatha Class I Ostracodermi Eg: Cephalaspis., Class II Cyclostomata Eg: Petromyzon
Division 2 – Gnathostomata
Super class Pisces - Class: Chondrichthyes., Sub class – Elasmobranchi Eg: Narcine Sub class Holocephali Eg: Chimaera
Class: Osteichthyes., Sub class – Choanichthyes., Order 1 Crossopterigii Eg:Latimeria., Order 2 Dipnoi Eg: Lepidosiren., Sub class: - Actinopterygii., Super order
1. Chondrostei Eg: Acipencer., Super order 2. Holostei Eg: Amia., Super order
3. Teleostei Eg: Sardine., Super class: Tetrapoda, Class Amphibia., Order I Anura Eg: Frog., Order II Urodela Eg: Amblystoma
Order III Apoda Eg: Ichthyophis.Class Reptilia - Sub class I: Anapsida., Order Chelonia Eg: Chelone., Sub class II: Parapsida Eg: Ichthyosaurus., Sub class III: Diapsida., Order I Rhynchocephalia
Eg: Sphenodon., Order II Squamata Eg: Chamaleon., Sub class IV: Synapsida Eg: Cynognathus
Class Aves - Sub class I: Archeornithes Eg: Archaeopteryx ., Sub class II:Neornithes Super order I: Palaeognathe Eg: Struthio., Super order II:Neognathe Eg; Brahminy kite
Class Mammalia
Sub class I: Prototheria Eg: Echidna
Sub class II: Metatheria Eg: Macropus
Sub class III: Eutheria, Important orders with examples

References

1. *Anderson D.T. 2001. Invertebrate Zoology Sec Edition Oxford University Press*
2. *Barnes R.D. 1987. Invertebrate Zoology. W. B. Saunders. New York.*
3. *Ekambaranatha Iyer 2000. A Manual of Zoology Vol. II .S. Viswanathan Printers &Publishers. Pvt. Ltd.*
4. *Hyman L. H. The Invertebrate Volumes. Mc Graw Hill.*
5. *Jordan. E. L., and Verma P.S. 2000. Invertebrate zoology. S. Chand & Co. ltd.,Delhi.*
6. *Kotpal R. L, Agarval S. K. and R. P. Khetharpal 2002. Modern Textbook of Zoology.*
7. *Kotpal R.L. 2000, Modern Text Book of zoology, Vertebrates, Rastogi Publications,Meerut.*
8. *Parker & Haswell. Textbook of Zoology. Invertebrate .*
9. *Young J.Z. 2006 The life of Vertebrates. Oxford University Press, India Ed.*
10. *Zoological Society of Kerala Study material. Animal Diversity 2002.*

IMSE402MM Integral Transforms and Partial Differential Equations

Credits 3 (3-1-0)

ModuleI:Laplace Transforms

Inverse Transforms, Properties, Transforms of Derivatives and Integrals, Second Shifting Theorem, Unit Step Function and Dirac-Delta Function, Differentiation and Integration of Transforms.

ModuleII:Convolution

Initial and Final Value Theorems, Periodic Functions, Solving Linear Ordinary Differential Equations with Constant Coefficients, System of Differential Equations and Integral Equations.

ModuleIII:Fourier series

Arbitrary period, Even and odd functions Half range expansions, Approximation by trigonometric Polynomials .

Module IV:Fourier Integrals

Fourier Integral theorem. Fourier Sine and Cosine Transforms. Linearity, Fourier transform of derivatives, Convolution Theorem .

ModuleV:Partial Differential Equations

Surfaces and Curves in three dimensions, solution of equation of the form $\frac{dx}{P}=\frac{dy}{Q}=\frac{dz}{R}$. Origin of first order and second order partial differential equations, Linear equations of the first order, Lagrange's method

Reference books

1. *Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, Tenth Edition, 2016.*
2. *Ian Sneddon – Elements of Partial Differential Equation (Tata Mc Graw Hill)*

IMSE402ES Air, Water and Soil Chemistry

Credits 3(3-1-0)

Module I: Introduction to Environmental Chemistry
Atoms and molecules, mole concept, molarity and normality, quantitative volumetric analysis. Thermodynamic system; types of chemical reactions; acids, bases and salts, solubility products; solutes and solvents; redox reactions, concepts of pH and pE

ModuleII: Atmospheric Chemistry
Composition of atmosphere; photochemical reactions in atmosphere; smog formation, types of smog (sulphur smog and photochemical smog), aerosols; chemistry of acid rain, case studies; reactions of NO2 and SO2; free radicals and ozone layer depletion, role of CFCs in ozone depletion.

Module III: Water Chemistry
Chemical and physical properties of water; alkalinity and acidity of water, hardness of water, calculation of total hardness; solubility of metals, complex formation and chelation; colloidal particles; heavy metals in water.

Module IV: Soil Chemistry
Soil composition; relation between organic carbon and organic matter, inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium in soil; phenolic compounds in soil.

ModuleV: Spectroscopic Concepts
Introduction to the concept of absorption and transmission of light, Beer–Lambert law, photovoltaic and solar cells; scattering of light, Rayleigh and Mia scattering. concept of heat transfer, conduction, convection; concept of temperature, lapse rate (dry and moist adiabatic); laws of thermodynamics; concept of heat and work, Carnot engine.

References:

1. *Beard, J.M. 2013. Environmental Chemistry in Society (2nd edition). CRC Press.*
2. *Boeker, E.&Grondelle, R. 2011. Environmental Physics: Sustainable Energy and Climate Change. Wiley.*
3. *Connell, D.W. 2005. Basic Concepts of Environmental Chemistry (2nd edition). CRC Press.*
4. *Girard, J. 2013. Principles of Environmental Chemistry (3rd edition). Jones & Bartlett.*
5. *Harnung, S.E. & Johnson, M.S. 2012. Chemistry and the Environment. Cambridge University Press.*
6. *Hites, R.A. 2012. Elements of Environmental Chemistry (2nd edition). Wiley & Sons.*
7. *Manhan, S. E. 2000. Fundamentals of Environmental Chemistry. CRC Press.*
8. *Pani, B. 2007. Textbook of Environmental Chemistry. IK international Publishing House.*

IMSC403GE Academic Writing

Credits 2(2-1-0)

Module I:Introduction to Research
Definitions, Functions, types, methods: Steps in research Process, abstraction of the research paper, drawing influences from data, internet and its applications, e-journals, Intellectual Property rights, Plagiarism

Module II: Literature Survey
Significance and approaches. primary and secondary sources including reviews, treatise and monographs, literature searching, review of work relevant to the chosen problem, Internet, Search engines and software: Online libraries, e-Books, e-Encyclopedia, Institutional Websites. various scientific data bases: SCOPUS, SCI-FINDER, Science Direct,G-Scholar etc and Introduction to important scientific Publishers: Wiley, Elsevier, Springer, Nature, Tayler and Francis etc.

Module III: Research Communication and scientific documentation
Project proposal writing, Research report writing, Structure of a scientific paper, Thesis, dissertation, research article, Presentation techniques: Oral presentation techniques, Assignment, Seminar, Debate, Workshop, Colloquium, Conference, Sources of Information: Primary and secondary sources. Library-Books, Journals, Periodicals, Reference sources, Abstracting and indexing sources, Reviews,

ModuleIV: Academic writing
Technical report vs scientific report, writing a thesis or paper, general information, publication of research paper, Types of articles: Communication, Full paper, Review etc, layout of a paper/thesis,

submission of a paper, revision of a paper or thesis- editing and evaluating the final product, proof reading, final typed copy, art of writing a thesis. presenting a scientific seminar, Poster presentations, Proposal writing, presentation

References

1. *Swales, J.M., & Feak, C.B. (2012). Academic writing for graduate students: Essential Tasks and Skills (3rd ed.). Ann Arbor: University of Michigan Press.ISBN: 978-0472034758*
2. *Maimon, E.P., Peritz, J.H., & Yancy, K.B. (2007). A writer's resource: A handbook for writing and research. (2nd ed.). Boston: McGraw-Hill.*
3. *C.R. Kothari, Research Methodology, 2nd Edn., New Age International, 2004.*
4. *N. Moore, How to do Research: The Practical Guide to Designing and Managing Research Projects, 3rd Edn., Facet Publishing, 2006.*
5. *J. Anderson, Assignment and Thesis Writing, 4th Edn., John Wiley and Sons, 2002.*

- **IMSE404L M/H/S/A/F Second Language Elective-2** (2 credits)
  (Malayalam/Hindi/Sanskrit/Arabic/French)
- **IMSE405GEn General Elective-** (2 credits)
- **IMSC406 CH/PH/LS/CS/ES Major lab-1** (2 credits)
- **IMSC407 CH/PH/LS/CS/ESMajor lab-2** (2 credits)
- **IMSE408 CH/PH/LS/CS/ESn Major (Electives)-1 and 2** (2 credits)

SEMESTER V

- **IMSC501CH/PH/LS/CS/ES Major-1** (3 credits)
- **IMSC502CH/PH/LS/CS/ES Major-2** (3 credits)
- **IMSC503CH/PH/LS/CS/ES Major-3** (3 credits)
- **IMSC504CH/PH/LS/CS/ESMajor-4** (3 credits)
- **IMSC505CH/PH/LS/CS/ES/E Major (lab)-3** (2 credits)
- **IMSC506CH/PH/LS/CS/ES Major (lab)-4** (2 credits)
- **IMSE507CH/PH/LS/CS/ES-nMajor (Elective)-3** (2 credits)
- **IMSC508SMReview Documentation/Seminar**(2 credits)

SEMESTER VI

- **IMSC601CH/PH/LS/CS/ES Major-5** (3 credits)
- **IMSC602CH/PH/LS/CS/ES Major-6** (3 credits)
- **IMSC603CH/PH/LS/CS/ES Major-7** (3 credits)
- **IMSC604CH/PH/LS/CS/ESMajor (lab)-5** (2 credits)
- **IMSC605CH/PH/LS/CS/ESMajor (lab)-6** (2 credits)
- **IMSE606CH/PH/LS/CS/ES-nMajor (Electives)-4 and 5** (2 credits)
- **IMSC607PV Minor Project and Viva-Voce** (3 credits)

  Student shall do a minor project under the supervision of a faculty member and shall submit a report at the end of the semester VI. Viva-voce shall be conducted based on the project report and seminar.

Chemistry Major (Core Courses)

IMSC406CH Inorganic Chemistry Lab-1

Credits 2(0-0-6)

Primary and secondary standards – Standard solutions - Theory of titrations involving acids and bases, KMnO4, K2Cr2O7, I_2 and liberated I_2 – Complex metric titrations. Indicators: Theory of acid-base, redox, adsorption and complex metric indicators. Double burette method of titration: Principle and advantages

1. Volumetric analysis
   a. Redox titrations
      a) Permanganometry – 1. Estimation of oxalate, 2. Estimation of Calcium 3 . Estimation of nitrate 4. Estimation of Ferrous iron
      b) Dichrometry – 1. Estimation of Fe2+ - external and internal indicators. 2. Estimation of Fe3+ (after reduction)
      c) Iodimetry and Iodometry – 1. standardisation of sodium thiosulphate using potassium iodate, Electrolytic copper and potassium dichromate 2. Estimation of As2O3 and arsenite 3. Estimation of copper sulphate.
   b. Complexometric titrations 1. Estimation of Zinc 2. Estimation of Magnesium 3. Estimation of Calcium.
2 Ion Exchange Method: Separation and estimation of Mg(II) and Zn(II)
3 Solvent extraction: Separation and estimation of Mg(II) and Fe(II)
4 Practical application of titrations in common life
   a. Determination of acetic acid content in Vinegar by titration with NaOH.
   b. Determination of alkali content in antacid tablets by titration with HCl.
   c. Determination of copper content is basis by Iodometric titration.
   d. Determination of available chlorine in bleaching powder.
   e. Determination of COD of water samples
   f. Determination of hardness of water

References:

1. *G. Svehla: Vogel's Qualitative Inorganic Analysis.*
2. *J. Mendham, R. C. Denny, M. J. K. Thomas: Vogel's Text Book of Quantitative Chemical Analysis.*
3. *Vogel's Textbook of Quantitative Chemistry.*
4. *Synthesis & characterization of Inorganic Compounds by W. L. Jolly, Prentice Hall. Lab Skills*

IMSC407CH Organic Chemistry Lab-1

Credits 2(0-0-6)

1. Qualitative Analysis: Analysis of an organic mixture containing two solid components using water, NaHCO3, NaOH for separation and preparation of suitable derivatives.
2. One step organic synthesis: Rf determination, crystallization, melting point determination.
3. Column chromatography
   a. Separation of fluorescein and methylene blue
   b. Separation of leaf pigments from spinach leaves
   c. Resolution of racemic mixture of mandelic acid

References:

1. *Vogels Textbook of Practical Organic Chemistry*
2. *Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal*
3. *Experimental Organic Chemistry Vol 1 and 2, P R Singh, D S gupta, K S Bajpai, Tata McGraw Hill*
4. *Laboratory Manual in Organic Chemistry, R. K. Bansal, Wiley*.

IMSC501CH Physical Chemistry 2

Credits 3(3-1-0)

Module I: Phase Equilibria

Terms ,concept of phase, component and degree of freedom, Gibbs Phase Rule. Clausius-Clapeyron equation and its applications, phase equilibria for one component systems(CO_2&Sulfur), with applications. Two component systems (Bi -Cd): Simple eutectic system (Pb-Ag), Solid solutions, Two component systems involving formation of compounds with congruent melting points. (Mg- Zn and incongruent melting points (Nacl- H2O, Ferric chloride - water & copper sulfate water, sodiumsulphate-water system). Freezing mixtures-Thermal analysis-Cooling curve method -Deliquescence and efflorescence. Liquid-liquid equilibria – Partially miscible and immiscible liquid systems -CST, Steam distillation. Nernst distribution law: Derivation and applications

Module II: Solutions& Colligative Properties

Different kinds of solutions ,Vapour pressure - Solubility of gases in liquids , Henry's law and its applications, Raoult's law - Ideal and non -ideal solutions, Non ideal systems, azeotropes, Partially miscible liquids(Phenol-water),Dilute solutions. Colligative properties:Relative lowering of vapour pressure-Elevation of boiling point -Depression in freezing point -Osmotic pressure -Reverse osmosis and its applications - Application of colligative properties ,Abnormal molecular mass -Van't Hoff factor. Surface tension, Viscosity: Determination of molecular mass from viscosity measurements. Refraction: Refractive index -Molar refraction and optical exaltation - applications

Module III: Chemical kinetics & Catalysis

Derivation of rate constants,Half-life period (derivation for first and n th order reactions). Factors affecting the rate of reactions - Methods to determine the order of a reaction, Arrhenius equation-Effect of temperature on reaction rates. Determination and significance of Arrhenius parameters -Theories of reaction rates- rate equation for bimolecular reactions using collision theory – Transition state theory – Expression for rate constant based on equilibrium constant and thermodynamic aspects– Unimolecular reactions – Lindemann mechanism.

Catalysis: Homogeneous and heterogenous catalysis – Theories of homogenous and heterogenous catalysis – Enzyme catalysis – Michaelis-Menten equation (derivation not required).

Module IV: Electrochemistry-II

Nernst distribution law-thermodynamic , applications, Types of cell and electrodes Standard electrode potential-Electrochemical series and its significance. Electrolytic and Galvanic cells , Nernst equation for electrode potential and EMF of a cell, Gibbs Helmholtz equation to galvanic cells. Concentration cell, with and without transport, liquid junction potential, application of concentration cells, solubility product and activity coefficient, corrosion: types, theories and methods of control.- Electrochemical theory of corrosion of metals,fuel cell

Module V: Colloids

Definition of colloid, classification of colloids. Solids in liquids (sols): properties- kinetic, optical and electrical: stability of colloids, protective action Hardy-Schulze law, gold number. Liquids in solids (gels): classification, preparation and properties, inhibition,surfactants,Emulsions. Properties and applications. Zeta potential, Donnan membrane equilibrium- Dorn effect, general application of colloids.

References:

1. *Modern Electrochemistry – Vol – I & II, by J. O. M. Bockris& A. K. N. Reddy, Plenum.*
2. *The Elements of Physical Chemistry, P. W. Atkins, Oxford*
3. *Physical Chemistry, G. M.. Barrow, McGraw Hill*
4. *Physical Chemistry through problems: S. K. Dogra & S. Dogra, Wiley Eastern Ltd.*

IMSC502CH Theoretical Chemistry

Credits 3(3-1-0)

Module I: Quantum Mechanical Treatment of Atom

blackbody radiation, Planck's quantum hypothesis, Einstein's generalization of quantum theory, Bohr's theory&calculation of Bohr radius, Atomic spectra of hydrogen and hydrogen like systems.matter waves-wave-particle duality. Heisenberg uncertainty principle, Electron diffractionexperiments. Concept of

Operators, Postulates of quantum mechanics. Time independent Schrödinger wave equation. Application to particle in a -one-dimensional box-three dimensional box, Application of Schrödinger wave equation to hydrogen atom. Wave functions or atomic orbitals, significance of wave functions. Quantum numbers,Aufbau and Paulis exclusion principles. Hund's multiplicity rule, Variation of orbital energies with atomic number, electronic configuration of elements, effective nuclear charge and shielding, shape of s,p,andd orbitals and their characteristics

Module II: Bonding in Diatomicmolecules

Itroductionof approximation methods in multi-electron systems. Born-Oppenheimer approximation. Variation theorem (basic idea only). Quantum mechanical concept of bonding -mixing of wave functions. Valence bond theory of H2 molecule . Molecular orbital theory of H_2^+ ion H_2 molecule - linear combination of atomic orbitals (LCAO) and coefficients in the linear combination. Potential energy diagram of H_2 molecule-equilibrium geometry. Bonding and antibonding molecular orbitals, MO diagrams of homonuclear and heteronuclear diatomic molecules, Comparison of VB and MO theories.

Module III: Bonding in Polyatomic Molecules

VSEPR theory: Postulates & applications. Concept of Hybridization, Definition (mixing of wave functions of the same atom), LCAO of the central atom – coefficients of atomic orbitals in the linear combination of sp,sp2 and sp3 hybridization, Other examples of hybridization –

Module IV: Multi-electron Systems

The Stern-Gerlach experiment and the concept of electron spin, spin quantum number, spin orbitals (elementary idea only). Pauli's exclusion principle. Quantum numbers and vectors, mutual inclination of electron orbits and resultant vectors, Russel-Saunders (L-S) coupling, J-J coupling, ground states term symbols, microstates and derivation of Russell-Saunders terms: and p&d configuration (p^2, d^2),

References:

1. *Chemistry of the Elements by N. N. Greenwood &Earnshow, Pergamon*
2. *Basic Inorganic Chemistry by F. A. Cotton & Wilkinson, John Wiley*
3. *Inorganic Chemistry by J. E. Huhey, Harpes& Row*
4. *B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry,*
5. *Satya Prakash, Advanced Inorganic Chemistry, Vol. 1, 5 thEdn.*
6. *J. D. Lee, Concise Inorganic Chemistry, 5th Edn*

IMSC503CH Organic Chemistry-2

Credits 3(3-1-0)

Module I:Aryl Compounds

The aryl group, Aromatic nucleus and side chain, Side chain reactions of benzene derivatives, Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.

Module II: Alkyl and Aryl Halides

Methods of formation alkyl halide, Mechanisms of nucleophilic substitution reactions of alkyl halides, substitution at the allylic and vinylic positions of alkenes, Mechanisms of elimination reactions of alkyl halides. Methods of formation of aryl halides, nuclear and side chain reactions. The addition-elimination and the elimination-addition, mechanisms of nucleophilic aromatic substitution reactions.

Module III: Ethers and Epoxides

Nomenclature and methods of formation, physical properties, Chemical reactions: cleavage and autoxidation, Zeisel's method. Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Module IV: Aldehydes and Ketones

Preparation of aldehydes and ketones, Oppeanauer oxidation. Synthesis of aldehydes and ketones from acid chlorides, 1,3-dithianes, nitriles and carboxylic acids, Physical properties. Mechanism of nucleophilic additions to carbonyl group: Perkin and Knoevengel condensations, Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction, Use of acetals as protecting group. Reactions of aldehydes and ketones (Reduction using $LiA1H_4$, Clemensen and Wolf-Kishner reduction, reaction with alcohols) Baeyer-Villiger oxidation, Meerwein-PondorofVerley, Clemmensen, and $NaBH_4$reductions, Mechanism of Aldol condensation, Cannizzaro's reaction, Reimer – Tiemann reaction, Perkin's reaction, Benzoin condensation.

Module V: Carboxylic Acids & Derivatives

Acidity of Carboxylic Acids, Effects of Substituent's on Acid Strength. Preparation and reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Mechanisms of esterification and hydrolysis (acidic and basic). Reduction of carboxylic acids, Mechanism of decarboxylation, effect of heat and dehydrating agents, methods of formation and chemical reactions of unsaturated monocarboxylic acids, Dicarboxylic acids, haloacids, hydroxy acids-Malic, tartaric & citric acid and acid anhydrides. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

References:

1. *Organic Chemistry", I. L. Finar, Vol. I & II, 5th Edition (1975), Longman Ltd., New Delhi.*
2. *Organic Chemistry, Morrison and Boyd, Prentice Hall.*
3. *Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.*
4. *A Guide Book to Mechanism in Organic Chemistry", P. Sykes, Orient Longman Ltd.*
5. *Fundamentals of Organic Chemistry, Solomons, John Wilev.*

IMSC504CH Organic Chemistry-3

Credits 3 (3-1-0)

Module I: Nitrogen Compounds

Mechanisms of nucleophilic Substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid. Halonitroarenes: reactivity, structure and nomenclature, physical properties, Stereochemistry of amines. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds, Gabriel-Phthalamide reaction, Hoffmann bromamide reaction, Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid.

Module II: Organosulphur Compounds

Nomenclature, structural features, Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidine

Module III: Heterocyclic Compounds

Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and sixmemberedheteroeycies. Preparation and reactions of Indole, quinoline and isoquinolme with special reference to Fischer indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

Module IV: Organometallic Compounds

Principle, preparations, properties and applications of the following reagents in organic synthesis with Mechanistics details: Group-I & II metal organic compounds-Li, M, Hg, Cd, Zn & Ce compounds. Transition metals-Cu, Pd, Ni, Fe, Co, Rh, Cr &Ti compounds.

References:

1. *Organic Chemistry", I. L. Finar, Vol. I & II, Longman Ltd., New Delhi.*
2. *Organic Chemistry, Morrison and Boyd, Prentice Hall.*
3. *Metalo-organic Chemistry by A. J. Pearson, Wiley*
4. *A Guide Book to Mechanism in Organic Chemistry", P. Sykes, Orient Longman Ltd.*
5. *Fundamentals of Organic Chemistry, Solomons, John Wilev.*
6. *Organic Chemistry, Clayden, Greeves, Warren and Wothers, Oxford University Press, USA*

IMSC505CH Physical ChemistryLab-2

Credits 2 (0-0-6)

1. Determination of overall order of saponification of ethyl acetate.
2. Study of glycerine-water system and determination of percentage of glycerine using viscometer
3. Determination of the surface tension of a liquid or a dilute solution (NaCl / surfactant) using a stalagmometer
4. Determination of cryoscopic constant (Kf) of solid solvent using a solute of known molecular mass(Cooling curve method)

5. Determination of molecular mass of the solute using a solvent of known cryoscopic constant (Kf).
   Solid solvents: Naphthalene, biphenyl, camphor. Solutes: Naphthalene, biphenyl, 1,4dichlorobenzene, diphenylamine, acetanilide, benzophenone.
6. Determination of molal transition point depression constant (Kt) of salt hydrate using solute of known molecular mass.
7. Determination of molecular mass of the solute using a solvent of known molal transition point depression constant (Kt).
   Salt hydrates: $Na_2S_2O_3.5H_2O$, $CH_3COONa.3H_2O$. *Solutes: Urea, Glucose*
8. Determination of specific reaction rate of the hydrolysis of methyl acetate catalysed by hydrogen ion at room temperature.

References

1. *Findley's Practical Physical Chemistry, B. P. Levitt, Longman*.
2. *J. B. Yadav, Advanced Practical Physical Chemistry,*
3. *D. P. Shoemaker, C. W. Garland, Experiments in Physical Chemistry,*
4. *W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press,*
5. R. C. Das, B. Behra, *Experiments in Physical Chemistry,*
6. P. S. Sindhu, *Practicals in Physical Chemistry - A Modern Approach*

IMSC506CH Inorganic Chemistry lab-2

Credits 2(0-0-6)

Principles in the separation of cations in qualitative analysis - Applications of common ion effect and solubility product - Microanalysis and its advantages.

1. Qualitative inorganic analysis of mixtures containing not more than 4 radicals (two cations and two anions) from the following:
2. Cation Radicals, NH_4^+, Ca^{+2}, Sr^{+2}, Ba^{+2}, Al^{+3}, Cr^{+3}, Mn^{+2}, Fe^{+3}, Co^{+3}, Ni^{+2}, Cu^{+2}, Zn^{+2} Mg^{+2} Pb^{+2}. Anion Radicals: CO_3^{2-} $C_2O_4^{2-}F^-$, Cl^-, Br-, Br^- , I^-, SCN^-, S^{2-}, SO_4^{2-}, $S_2O_3^{2-}$, NO_3^-, PO_4^{3-}, $B_2O_3^{3-}$, CrO_4^{2-}/ $Cr_2O_7^{2-}$,SO_4^{2-} Insoluble Materials: Al2O3, Fe2O3, Cr2O3, SnO2, SrSO4, BaSO4, CaF2.
   Experiment A: Preliminary Tests for acid and basic radicals in given samples.
   Experiment B: Wet tests for Acid and Basic radicals in given samples.
   Experiment C: Identification and Confirmatory tests.
3. Preparation of some Inorganic compounds and its characterization using UV-VIS, IR spec.
   Mohr Salt from Kipp'swaste, Nickel dimethyl glyoximate, Potassium trisoxalato ferrate (III) , Tristhioureacopper (I) sulphate, Tetraammine copper (II) sulphate etc.
4. Colorimetry/spectrophotometry: Verification of Beer-Lambert law for KMnO4 and K2Cr2O7 & determination of concentration of the given solution. (a) . Estimation of iron. (b). Estimation of chromium(c). Estimation of nickel

References:

1. *Vogel's Textbook of Quantitative Chemistry.*
2. *Synthesis & characterization of Inorganic Compounds by W. L. Jolly, Prentice Hall.*
3. *Vogel's Text book of Macro &Semimicro Qualitative Analysis*

IMSC601CH Physical Chemistry-3

Credits 3(3-1-0)

Module 1: Molecular Symmetry and Group Theory

Introduction to Elements of symmetry of molecules (Identity, proper axis of rotation, plane of symmetry, centre of symmetry and improper axis of rotation) – corresponding symmetry operations – Schoenflies notation – binary combinations of symmetry operations. Rules for a set of elements to form a mathematical group - point group classification of simple molecules – Cnv, Cnh, Dnh. Group multiplication table for C2v and C2h.

Module II: Molecular Spectroscopy

electromagnetic radiation, Interaction of electromagnetic radiation with matter - Qualitative aspects, line width and intensity of signal (basic idea), Energy levels in molecules,

Rotational Spectroscopy: Rigid rotor- Expression for energy- Selection rules- Intensities of spectral lines Determination of bond lengths of diatomic molecules.

Vibrational Spectroscopy: Simple harmonic oscillator -Energy levels -Force constant- Selection rules - Anharmonicity -Fundamental frequencies - Overtones –Fingerprint- Group frequency concept -Degree of freedom for polyatomic molecules -Modes of vibrations

Raman Spectroscopy: Basic principles -concept of polarizability- Qualitative treatment of pure rotational -Vibrational Raman spectra - Stokes & anti-stokes lines and their intensity difference-Selection rules - Mutual exclusion principle.

Electronic Spectroscopy: Basic principles-Frank-Condon principle -Electronic transitions- Beer Lamberts law, Dissociation energy of diatomic molecules -Chromophore and auxochrome- Bathochromic and hypsochromic shifts.

Nuclear Magnetic Resonance (NMR) Spectroscopy: Proton NMR & 13C NMR- Principle-Number and position of signals, Chemical shift, Different scales, Spin-spin coupling (qualitative concept). NMR spectra of simple molecules. Electron Spin Resonance (ESR)Spectroscopy:Principle-Hyperfine structure.

Module III: Photochemistry

Difference between thermal and photochemical processes-Beer Lambert's law, Laws of photochemistry: Grothus-Draper law and Stark-Einstein's law of photochemical equivalence. Quantum yield and its explanation-Photophysical processes: Jablonski diagram, Photosensitization -Chemiluminescence-Photochemical reactions (hydrogen-chlorine and hydrogen-bromine).

Module IV: Introduction to Instrumental Methods of Analysis

Principle, and applications of following spectrophotometers - Atomic Absorption Spectroscopy (AAS), Flame Emission Spectroscopy -Colorimetry -Spectrophotometry, Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Thermogravimetry (TGA), Differential Scanning Calorimetry (DSC) and Cyclic Voltammetry (CV).

ModuleV: Surface Chemistry & Adsorption

Physical and chemical adsorption – Adsorption isotherms – Langmuir. Freundlich andB.E.T. equations (B.E.T. no derivation) – Gibbs adsorption equation — Mathematicalderivation – Surface films - Determination of surface area using Langmuir and B.E.T.equations.

References:

1. *The Elements of Physical Chemistry, P. W. Atkins, Oxford*
2. *Physical Chemistry, G. M.. Barrow, McGraw Hill*
3. *Physical Chemistry through problems: S. K. Dogra & S. Dogra, Wiley Eastern Ltd*.

IMSC602CH Inorganic Chemistry-2

Credits 3(3-1-0)

Module I: Coordination Chemistry-1

Coordinate bond, Werner's theory, ligand, coordination number, homoleptic and heteroleptic complex, isomerism in coordination compounds,bonding theories: EAN rule -Valence Bond theory and its limitation, Crystal filed theory ,CFSE of low spin and high spin octahedral complexes ,Spectrochemical series , Jahn-Teller Theorem, Molecular orbital theory for octahedral complexes (with sigma bonds only). Colour of the coordination complexes. Electronic spectra, Magnetic properties. Stability of complexes: Inert and labile complexes,Factors influencing stability. Chelate effect, polynuclear complexes, Application of complexes in qualitative and quantitative analysis

Module II: Coordination Chemistry-II

Thermodynamic and kinetic stability of coordination complexes, Reaction kinetics of the formation of coordination complexes, Trans effect, theories of trans effect, mechanism of trans effect, kinetics of substitution reactions in square planar complexes. Thermodynamic and kinetic stability including factors affecting them. Labile and inert complexes**.** Electron transfer reactions, Inner sphere, outer sphere, without breaking M-L bond.

Module III: Organometallic Chemistry

Structure and bonding in transition metals, ligands commonly encountered in organometallic chemistry

Uniqueness of carbon, covalent bond, coordinate bond, bonding in carbon monoxide. Definition-Classification based on the nature of metal-carbon bond -Zeise's salt. 18- Electron rule. Metal carbonyls - Mononuclear and Polynuclear carbonyls of Fe, Co and Ni (structure only) -Bonding in metal carbonyls.

Ferrocene: Preparation, properties and bonding (VBT only). Chemical behavior of organometallic compound-metal centered reactions and ligand modification reactions, Applications in organic synthesis-Catalysis: Zeigler Natta catalyst for polymerization and Wilkinson catalyst for hydrogenation of alkene.

Module IV: Inorganic Cages &polymers

Inorganic Rings, chains and cages Catenation and Heterocatenation, Heterocyclic Ring System-Borazines, Phosphazines- Monomer and Polymer, S-N ring compounds, Homocyclic rings of S, Se and Te. Silicates minerals, Isopolyanions, Boranes: boron cage compounds-closo, nido, arachno, carboranes; cage compounds of S and P. Inorganic Polymers: Heterocatenation. Structure and applications of silicones and silicates. Phosphazenes: Preparation, properties and structure of di and tri phosphonitrilic chlorides. SN compounds: Preparation, properties and structure of S2N2, S4N4 and (SN)x.

Module V: Redox Chemistry &Metallurgy

Standard reduction potentials,Formal Potential and its application: Effect of pH**,** complexation, solubility; Disproportionation and comproportionationreaction, Electrometallurgy-Hydrometallurgy, Applications of redox reactions to the extraction of elements from their ores: : Electrolytic refining, ion exchange method, zone refining, vapour phase refining and oxidative refining, Ellingham diagrams-Extractive metallurgy of Al, Fe, Ni, Cu, Ti and U. Alloys: Definition, Composition and uses, . Steel: Open hearth process-classification of steel, Composition of alloy steels properties and applications.

References:

1. *Basic Inorganic Chemistry by F. A. Cotton & Wilkinson, John Wiley*
2. *Inorganic Chemistry by J. E. Huhey, Harpes& Row*
3. *Comprehensive Co-ordination Chemistry by G. Wilkinson et.al. Pergamon*
4. *Concise Inorganic Chemistry by J D Lee.*
5. *P. Powell, Principles of Organometallic Compound*
6. *Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry, Pearson,*

IMSC603CH Organic Chemistry-4

Credits 3(3-1-0)

Module I: Spectroscopic Characterization of Organic Molecules

Basic principles of UV-VIS and, FTIR, spectroscopy. Brief application of spectroscopic characterization of organic molecules.

Module II: NMR Spectroscopy and Structure Determination

Nuclear magnetic resonance (NMR) spectroscopy: Proton magnetic resonance (1H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone, Brief introduction to ^{13}C NMR, Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and NMR spectroscopic techniques.

Module III: Alkanes and Cyclolkanes

Corey House reactions and decaroxylation of carboxylic acids, Mechanism of free radical halogination of alkanes, Cycloalkanes: Nomenclature, methods of preparations, chemical reactions, Bayer's strain theory and its limitations, Ring strain in cyclopropane and cyclobutanes, Theory of stainless rings. The case of cyclopropane ring: banana bonds.

Module IV: Alkenes, Cycloalkenes, Dienes and Alkynes

Regio-selectivity: Saytzeff rule, Hoffmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes: hydroboration-oxidation, oxymercuration-reduction, Epoxidation, hydration, polymerization of alkenes, Substitution at the allylic and vinylic positions of alkenes. Cycloalkenes: conformation, synthesis, and chemical reactions. Dienes: nomenclature, isolated, conjugated and cumulated dienes: structure, method of formation, polymerization, chemical reaction-1,2 and 1,4 additions, diels-alder reaction. Alkynes: hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization

Module V: Introductory Photochemistry and Pericyclic Chemistry

Principles of photochemistry, photochemical reactions of carbonyl compounds and olefins. Concerted reaction, Molecular orbital theory, LCAO methods, bonding and anti-bonding orbitals, orbital symmetry, correlation diagram for electrocyclic reactions, Diels-Alder reaction.

References:

1. *Organic Chemistry", I. L. Finar, Vol. I & II, Longman Ltd., New Delhi.*
2. *Organic Chemistry, Morrison and Boyd, Prentice Hall.*
3. *Organic reaction and mechanism-structure and reactivity by Jerry March*
4. *A Guide Book to Mechanism in Organic Chemistry", P. Sykes, Orient Longman Ltd.*

IMSC604CH Physical Chemistry lab-3

Credits 2(0-0-6)

1. To titrate potentiometrically the given ferrous ammonium sulphate solution using $KMnO4/K_2Cr_2O_7$ as titrant and calculate redox potential of $Fe+^2/fe+^3$system on hydrogen scale.
2. Determination of composition of glycerine-water mixture by refractive index method.
3. Determination of refractive indices of KCl solutions of different concentration andConcentrations of unknown KCl solution.
4. Verify Lambert-Beer's law and determine molar extinction coefficient, concentration ofany one, CuSO4 / Ferric alum / KMnO4 / K2Cr2O7 in a solution. Find out the unknownConcentration of the given solution of the substance.
5. Construction of phase diagram & determination of eutectic composition and eutecticTemperature: (Naphthalene-biphenyl system, Naphthalene-diphenyl amine system, Biphenyl–diphenylamine system).
6. Study the mutual solubility of Phenol and water at various temperatures and hence determine the CST.
7. Determination of Molecular wt. Of a non-volatile solute by Rast Method/ Beckmann Method.
8. Investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir Isotherms

References:

1. *Findley's Practical Physical Chemistry, B. P. Levitt, Longman*
2. *J. B. Yadav, Advanced Practical Physical Chemistry,*
3. *D. P. Shoemaker, C. W. Garland, Experiments in Physical Chemistry,*
4. *W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press,*

IMSC605CH Organic Chemistry Lab-3

Credits 2 (0-0-6)

1. Synthesis of Organic Compounds
   a. Acetylation of salicylic acid, aniline, glucose and hydroquinone.
   b. Benzoylation of aniline and phenol
   c. Aliphatic electrophilic substitution: Preparation of iodoform from ethanol and acetone
   d. Aromatic electrophilic substitution
      i. Nitration: Preparation of m-dinitrobenzen, Preparation of p-nitroacetanilide
      ii. Halogenation: Preparation of p-bromoacetanilide, Preparation of 2,4,6-tribromophenol
   e. Diazotization/Coupling: Preparation of methyl organge and methyl red
   f. Oxidation: Preparation of benzoic acid from toluene
   g. Reduction: Preparation of aniline from nitrobenzene, Preparation of m-nitroaniline from m-dinitrobenzene.
2. Two-step organic synthesis:
   a. Characterization by Rf determination, crystallization and melting point determination.
3. Characterization understanding through UV, IR and NMR spectroscopic analysis.

References:

1. *Vogels Textbook of Practical Organic Chemistry*
2. *Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal*
3. *Experimental Organic Chemistry Vol 1 and 2, P R Singh, D S gupta, K S Bajpai, Tata McGraw Hill*
4. *Laboratory Manual in Organic Chemistry, R. K. Bansal, Wiley.*

Chemistry Major (Elective Courses)

IMSE408CH-1 Polymer Chemistry

Credits 2(2-1-0)

ModuleI:Introduction to Polymers
Importance of polymers, Basic concepts: monomers, repeat units, degree of polymerization, linear, branched and network polymers, classification of polymers, polymerization: condensation, addition and free radical chain-ionic and coordination and co-polymerization, polymerization conditions and polymer reactions; Kinetics & mechanism of polymerization in homogenous and heterogeneous systems.

ModuleII:Polymer Characterization
Polydispersion and molecular weight concept, number average, weight average and viscosity average molecular weights, polydispersity and molecular weight distribution, The practical significance of molecular weight, measurement of molecular weights, end group, viscosity, light scattering, osmotic and ultracentrifugation methods, analysis and testing of polymers, chemical analysis of polymers, spectroscopic methods, X-ray diffraction study, microscopy, Thermal analysis and physical testing-tensile strength, Fatigue, impact, tear resistance, hardness and adhesion resistances.

ModuleIII:Structure and Properties
Morphology and order in crystalline polymer configurations of polymer chains, crystal structure of polymers, morphology of crystalline polymers, strain induced morphology, crystallization and melting, crystalline melting temperature Tm, effect of chain flexibility and steric factors, entropy and heat of fusion. The glass transition temperature Tg, relationship between Tm and Tg, effects of molecular weight, diluents, chemical structures, chain topology, branching and cross linking, property requirements and polymer utilization.

Module IV: Applications of Commodity Polymers
PE, PVC, Polyamides, Polyesters, Phenolic resins, epoxy resins, silicone polymers, Functional polymers, Fire-retarding polymers and electrically conducting polymers, biomedical polymers: contact lens, dental polymers, artificial hearts and skin materials

References:

1. *Text book of polymer sciences, F. W. Billmeyers, Jr., Wiley*
2. *Polymer Sciences, V.R. Gowariker, N. V. Biswanathan, J. Sreedhar, Wiley-Eastern*
3. *Contemporary polymer chemistry, H. R. Alcock, F. W. Lambe, Prentice Hall*

IMSE408CH-2 Environmental Chemistry

Credits 2(2-1-0)

ModuleI: Introduction
Role, importance and scope of environmental chemistry, multidisciplinary nature Concept of an ecosystem, structure and function of an ecosystem, energy and nutrient flow, biogeochemical cycles, sources, pathways and fate of environmental pollutants-Environmental transformation & degradation processes

ModuleII: Atmospheric Chemistry
Chemical composition of the earth's atmosphere, units for expressing atmospheric concentration Various segments of atmosphere & their significance, sources and toxic effects of air pollutants, Stratospheric Chemistry- Ozone,formation& turnover of ozone, processes for catalytic decomposition of ozone, chlorofluorocarbons, arctic & Antarctic ozone hole formation. Tropospheric Chemistry- Smog, Phototransformation, types of hydrocarbon in the troposphere, reaction of organic compounds in the atmosphere .Chemistry of photochemical smog, emissions from internal combustion engine and control measures , sulfurous smog & emissions from stationary sources and control measures Tropospheric Chemistry – Precipitation .acid rains, sources & sinks. Atmospheric Aerosols: Sources of aerosols, aerosol concentrations & life times, PM -2.5 & its significance, control of particulate emissions.The chemistry of global climate:Energy balance & earth's atmosphere, greenhouse gases & global warming

ModuleIII: Aquatic Chemistry
The Hydrosphere: physical & chemical properties of water, concentration units used for aqueous solutions , Water resources, Chemistry of natural waters, physico-chemical properties of water, Water pollution: Deoxygenating substances, influence of chemical process on dissolved oxygen, sources of water pollution, various pollutants their detrimental effects. Portability limits as per WHO & PHED specification, treatment of municipal supply water, slow sand filters, rapid sand filter, disinfections, their advantage & disadvantages, break point chlorination, Commonly used water purification techniques

ModuleIV: Soil Chemistry
Soil formation: Physical weathering ,chemicalweathering,Composition of soil, micro and macro nutrients, Physical & chemical properties of soil. Sources and chemical nature of soil contaminants, Distribution of soil contaminants: Soil –water partition process, soil- organism processes, Ecological and health effects of soil contaminants.

ModuleV:Chemistry of Solid wastes
Sources, Classification and composition of MSW, Properties of MSW, MSW management, Waste minimization, Life cycle assessment, benefits, waste reduction techniques, Reuse and recycling, Biological MSW treatment, Thermal treatment, Landfill, Integrated waste management. Radiation hazards: Types of radiation, sources, effects, control and disposal of nuclear waste.

References:

1. *Environmental Chemistry : a global perspective,G.W.vanLoon, S.J. Duffy,Oxford publication*
2. *Practical Environmental Analysis by Miroslav Radojevic and Vladimir N. Bashkin, RSC.*
3. *An Introduction to Environmental Science & Engineering by Gilbert M. Masters.*

IMSE408CH-3 Green Chemistry

Credits 2(2-1-0)

Module I: Introduction to Green Chemistry
What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Module II: Principles of Green Chemistry and Designing a Chemical synthesis
Twelve principles of Green Chemistry with their explanations and examples and specialemphasis on the following:

Module III: Designing a Green Synthesis
using these principles; Prevention of Waste/ byproducts;maximum incorporation of the materials used in the process into the final products ,Atom Economy, alculation of atom economy of the rearrangement, addition,substitution and elimination reactions.
Prevention/ minimization of hazardous/ toxic products reducing toxicity.
risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

ModuleIV:Green solvents
supercritical fluids, water as a solvent for organic reactions, ionicliquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solventsand how to compare greenness of solvents.

ModuleV: Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy. Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.
Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Module VI: Examples of Green Synthesis

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)

2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction

ModuleVII:Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

References:

1. *Ahluwalia, V.K. &Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005).*
2. *Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998).*
3. *Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).*
4. *Cann, M.C. &Connely, M.E. Real-World cases in Green Chemistry, ACS, Washington (2000).*
5. *Ryan, M.A. &Tinnesand, M. Introduction to Green Chemistry, ACS, Washington (2002).*
6. *Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition,2010.*

IMSE507CH-1 Biochemistry

Credits 2(2-1-0)

ModuleI:Chemistry of Biomolecules and Natural Products

Basic aspects(structure, chemistry and bonding),carbohydrates, amino acids and proteins, nucleic acids,terpenoids,alkaloids, fatty acids,steroids, plant pigments, lipids, and vitamins. Nomenclature of prostaglandins.Methods for primary structure determination of peptides, proteins and nucleicacids.

ModuleII: Reactions And Concepts in Protein Chemistry.

Concept of supramolecular assembliesbased on structural aspects-example proteins (enzymes) and biomembrane assemblies.

ModuleIII: Biocatalysis

with respect to conformations and structure and function relationship, enzymecatalysis, vitamins as co-factors, enzyme kinetics, graphical evaluation of KM and Vmax, enzymeinhibition, mechanisms regulatory aspects.

ModuleIV: Metabolism

overview and selected individual and important oxidative pathways.Glycolysis, TCA cycle-pentose phosphate pathway. Citric acid cycle: energetic and amphibolicnature. Regulatory aspects of TCA cycle and glycolysis. Photosynthetic electron transport andphosphorylation and CO2 fixation.

ModuleV:Transfer of Genetic Information

Chemistry of nucleic acids, nucleotide, nucleoside, cyclicAMP, assembly of DNA, types of RNA. Replication of DNA, flow of genetic information, protein biosynthesis,transcription and translation, Genetic code, regulation of gene expression, DNAsequencing. The Human Genome Project. DNA profiling and the PolymeraseChain Reaction (PCR).Repair ofDNA and recombinant DNA concept.

References

1. *A. Lehninger, Principles of Biochemistry, CBS Publishers, 1990.*
2. *R.W. McGilvery, G.W. Goldstein, Biochemistry: a Functional Approach, 3rd Edn.,Saunders, 1983.*
3. *G. Zubay, Biochemistry, 2nd Edn.,MacGraw Hill Ryerson, 1999.*
4. *P.S. Kalsi, Chemistry of Natural Products, Kalyani Publishers, 2001.*
5. *S.V. Bhat, B.A. Nagasampagi, M. Sivakumar, Chemistry of Natural Products, Springer, 2005*
6. *D.E. Metzler, Biochemistry: The Chemical Reactions of Living Cells, Academic Press, 2001.*

IMSE507CH-2 Computational Chemistry

Credits 2(2-1-0)

Module I: Introduction to Computational Chemistry and Molecular Modeling

Coordinate systems, Concept of 2D and 3D structure, molecules, Surfaces, Molecular energetic profile, Brief idea about the computational software's for drawing, visualization and simulation of small and large molecules. Basic concept of Chemoinformatics, 3D-Structure file system and Databases.

Module II:Quantum Mechanics & Molecular Mechanics

Molecular Orbital Theory, The Hartree-Fock method, ab-initio calculation, Semi-empirical methods, Huckel theory, Valence bond theories, Force Field, Geometrical Parameters, Non-covalent Parameters: understanding of electrostatic interactions, van der Waals interaction, Hydrogen bonding, hydrophobic interactions,; application of quantum mechanics and molecular mechanics in drug design.

Module III:Computer Simulation Methods

Minimization, Molecular dynamics, Monte Carlo Simulations, Simulated Annealing, Conformational Search and Conformational Analysis, Understanding of iterations, convergence, protocols and algorithm such as steepest descents, conjugate gradient etc.,

Module IV: Structure Activity Relationship (SAR)

Mathematical parameters or descriptors: Lipophilicity, Electronic and Steric factor, Mathematical Models based on physicochemical relations: Hammett equations, Taft Equation and Linear Free Energy Relationship (LFER), Hansch Equations and Hansch analysis, mixed approach, Other QSAR Approaches

References:

1 *Computational Chemistry, Intrn to Theory and Application of Molecular and Quantum Mechanics. By Errol Lewars, Springer*
2 *Molecular Modelling:Principle and Application, 2nd edn By A. R. Leach, Addison-Wesley Longman Ltd, 2001*
3 *E. Kreyszig, Advanced Engineering Mathematics, 10th Edn., John Wiley and Sons, 2011.*

IMSE606CH-1 Nano Materials

Credits 2(2-1-0)

Module I:General Introduction yo Nanomaterials

Emergence of nanotechnology,defining nanodimensional materials, size effects innanomaterials , Moore's law, , physical and chemical methods of synthesis of nanomaterials,synthesis and properties of fullerenes and carbon nanotubes,synthesis of nanoparticles of gold, silver, rhodium, palladium and platinum,techniques of synthesis-electroplating and electrophoretic deposition, conversionthrough chemical reactions and lithography. Thin films-chemical vapor depositionand atomic layer deposition techniques,

ModuleII:Diversity in Nanosystems

Nanofabricationmethods: top-down and bottom-up methods, self assembled monolayers on gold-growth processand phase transitions. Gas phase clusters- formation, detection and analysis.quantum concepts.Quantum dots- preparation, characterization and applications. Nanoshells-types ofsystems, characterization and application.

ModuleIII: Interfaces of Nanotechnology

Nanobiology, nanosensors, nanomedicines.Types of nanostructured materials: nanocrystals, nanoparticles, oxide nanostructures, nanotubes and nanowires. Characterization of nanoparticles: transmission electron microscopy(TEM), atomic forcemicroscopy(AFM), X-ray spectroscopy.

ModuleIV:Shape of Nanoparticles

Exterior surface and particle shape, interior nanoscale surfacearea, specific surface area, spherical cluster approximation, packing fractions and density,structural magic numbers.Nanooptics: interaction of light with nanoparticles, surface Plasmon resonance, colourgeneration from nanoparticles, quantum dots,Determination of nanoparticle size, surface area and porosity-BET method, BJH method,Mercury Porosimeter method.

References

1. *H.S. Nalwa, R. Smalley, Encyclopedia of Nanoscience and Technology, American Scientific Pub., 2004.*
2. *C.N. R. Rao, A. Govindraj, Nanotubes and Nanowires, 2nd Edn., RSC, 2011.*
3. *G. Schmid, Nanoparticles: From Theory to Applications, John Wiley & Sons, 2011.*
4. *G.L. Hornyak , H.F. Tibbals , et.al. Introduction to Nanoscience & Nanotechnology, CRC Press, 2009.*

IMSE606CH-2 Medicinal Chemistry

Credits 2(2-1-0)

Module I:General Aspects of Medicinal Chemistry
Basic terminology in drug discovery, IC50,LogP, LogD, MIC, efficacy, adsorption, distribution, metabolism and excretion, dose responsecurves, drug and disease classification, drug targets, pharmacology, pharmacokinetics, Lipinskirule.Stages in drug discovery, SAR and QSAR, natural and synthetic drugs. Introduction toprocess research.

ModuleII:Introduction to Drug Design
Modeling techniques, receptor proteins, drugreceptorinteraction, drug action, drug selectivity, drug metabolism.Important chemicals used in drug action, anticoagulants and anticoagulanttherapy, anti-anginal drugs, antihypertensive agents, antimalarial drugs,aminoquinolines and alkaloids.

ModuleIII: Introduction to Various Drugs
Antibiotics: Important penicillins, chloramphenicol, tetracyclins , antibacterials(Cipro and Zyvox)
Antiviral drugs(Tamiflu), Analgesics and anti inflammatory drugs(Celebrex), non-steroid antiinflammatory drugs(NSAIDS) like ibuprofen, naproxen.
Proton pump inhibitors:Hyperacidity, Peptic Ulcer Disease (PUD), gastroesophagealreflux disease (GERD), ATPase inhibitors-omeprazole and esomeprazole.Cardiovascular diseases: hypertension, cardiovascular drugs-Statin drugs

Module IV: Concept of Rational Drug Design
Structure activity relationship, Drug-receptor understanding, Molecular modeling, Structure based drug design. QSAR. Brief discussion about the rational discovery of anti-influenza compound and anti-HIV compound.

References

1. *W. Sneader, Drug Discovery: A History, John Wiley & Sons, 2006.*
2. *G.L. Patrick, An Introduction to Medicinal Chemistry, 4th Edn., Oxford University Press, 2011.*
3. *G. Thomas, Fundamentals of Medicinal Chemistry, John Wiley & Sons, 2003*
4. *A. Kar, Medicinal Chemistry, New Age International, 2005*
5. *R. Vardanyan, V.J. Hruby, Synthesis of Essential Drugs, Elsevier, 2006.*

IMSE606CH-3 SupramolecularChemistry

Credits2 (2-0-0)

ModuleI:Introduction to Supramolecular Chemistry
Definition and development of supramolecular chemistry, classifications of supramoleciular host-guest compounds, receptors, coordination and the lock and key analogy, the chelate and macrocyclic effects, preorganization and complementarity, thermodynamic and kinetic stability, nature of supramolecular interactions, supramolecular host design.

ModuleII:Methods for the Understanding of Supramolecular Systems
Applicationsof NMR and X-ray Crystallography, X-ray Crystallography, Single Crystal, Bragg condition, Miller indices, Laue method, Bragg method, Debye-Scherrer method of X-ray structure analysis of crystals, Index reflection, Identification of unit cells, Space Group, Structure of simple lattices and X-ray intensities, Structure factor and its relation to intensity and electron density.

ModuleIII: Supramolecular Chemistry and Non-covalent interaction
Supramoleculer assembly by Noncovalent interactions, Definition and examples of supramolecular system to understand noncovalent interaction such as weaker noncovalent interactions, hydrogen bonding, metal coordination, hydrophobic interactions, hydrophilic interaction, electrostatic interactions, van der Waals interactions, arene interactions, π… π interactions, C-H... π interaction, halogen interactions, cation… π interaction, and charge transfer interactions.

References:

1. *J. -M. Lehn, Supramolecular Chemistry: Concepts and Perspectives, VCH, Weinheim, 1995.*
2. *J. W. Steed and J. L. Atwood, Supramolecular Chemistry, John Wiley and Sons, New York, 2000*
3. *H. Dodziuk, Introduction to Supramolecular Chemistry, Springer, 2001.*
4. *P.D. Beer, P.A. Gale, D.K. Smith, Supramolecular Chemistry, Oxford University Press, 1999.*

Physics Major (Core Courses)

IMSC406PH Electricity and Magnetism Lab

Credits 2(0-0-6)

1. Charging and Discharging a Capacitor
2. Resonance in LCR Circuits
3. Electromagnetic Induction
4. Measurement of Average Resistance of a Wire by Carey-Foster method and to determine the value of unknown resistance
5. Comparison of E.M.F.'s of Two Cells with the Help of Potentiometer
6. Measurement of E.M.F. of a Cell by Potentiometer, Using a Milli-ammeter
7. Hysteresis Curve 8. Determination of the Moment of a Bar Magnet and the Horizontal Component of Earth's Magnetic Field by Magnetometers
8. Kelvin Double Bridge for Measuring Very Low Resistance

IMSC407PH Heat and ThermodynamicsLab

Credits 2(0-0-6)

1. Gas laws: Boyles law
2. Gas laws: Charles law
3. Constant volume gas thermometer
4. Electric Joule heating
5. Seebeck effect and thermocouple
6. Thermal conductivity of a poor conductor (Lees method)
7. Thermal conductivity of a good conductor (Searles method)
8. Specific heat capacity – Method of mixtures
9. Phase change – Latent heat
10. Stefan-Boltzmann law

References:

1. *Properties of Matter,D S Mathur*
2. *Practical Physics, P R Sasikumar Eastern Eco. Ed.*
3. *Advance level Practical Physics IV Ed., Nelkon and J M Ogborn*
4. *Advance course in Practical physics, D Chathopathyaya*
5. *Practical Physics,C L Arora*
6. *Electronics Lab Manuel , K A Navas*
7. *Digital fundamentals,Thomas L Floyed*
8. *A course of experiments with He-Ne Laser, R S Sirohi*
9. *Laboratory manael for introductory Electronic experiments, L K Maheswari & Nm S Anand*
10. *Optics, N Subramanyan, Brij Lal 7 Avadhanalu*

IMSC501PH Classical Optics

Credits 3(3-1-0)

Module I: Interference

Review of basic ideas of interference, Coherent waves-Optical path and phase changesuperposition of waves-theory of interference-intensity distribution. Young's double slit experiment, Coherence-Conditions for interference. Thin films-plane parallel film- interference due to reflected light-conditions for brightness and darkness-interference due to transmitted light-Haidinger fringes-interference in wedge shaped film-colours in thin films-Newton's rings-applications. Michelson interferometer-construction, working and just mention the applications.

Module II: Diffraction

Diffraction, Fresnel Diffraction – Huygens- Fresnel theory –zone plate –Difference between zone plate and convex lens. Comparison between interference and diffraction –diffraction pattern due to a straight edge, single silt. Fraunhoffer diffraction at a single slit, double slit,N slits, theory of plane transmission grating. Dispersive power and resolving power of grating.

Module III: Polarization

Polarization, Concept of polarization – plane of polarization- Types of polarized light-production of plane polarized light by reflection-refraction. Malu's law-Polarization by double refraction- calcite crystal. Anisotropic crystals-optic axis-Double refraction-Huygens explanation of double refraction. Retarders - Quarter wave plate and Half wave plate. Production and Detection of plane, elliptically and circularly polarized light-Optical Activity- specific rotation.

Module IV: Laser

Attenuation of light in an optical medium, thermal equilibrium, interaction of light with matter, Einstein's relations, light amplification, population inversion, active medium, pumping, metastable states, principal pumping schemes, optical resonator, axial modes. Types of lasers, semiconductor laser, Q switching, applications. Holography – principle of holography, application.

Referenes:-

1. *A Text book of Optics, N.Subramanayam, Brijlal, M.N.Avadhanulu, S. Chand & Co.*
2. *Fundamentals of physics:- Resnuk, Halliday, Krane, JohnWiley and Sons, 5th Ed.*
3. *Textbook of Optics, Ajoy Ghatak, Tata McGrowHills.*
4. *Handbook of Optics, Vol I and II, Michael Bags,(Ed), Mc GrowHills (1995)*
5. *Optics, S K Srivastava, CBS Pub. N Delhi*
6. *A Text book of Optics, S L Kakani, K L Bhandari, S Chand*

IMSC502PH Introductory to Quantum Theory and Special Relativity

Credits 3(3-1-0)

Module l: Historical Development of Quantum Theory

Millikan's oil-drop experiment. Thomson's model of the atom, Rutherford's experiment on scattering of alpha particles, Rutherford's scattering formula, Rutherford's model of the atom. Inadequacies of classical physics, The Blackbody radiation and Planck's hypothesis, The photoelectric effect, The Compton effect, Bohr's theory of hydrogen atom, Sommerfeld's modification, Quantum numbers, Wave particle duality, Davisson and Germer's electron diffraction experiment, G. P. Thomson's experiments, Uncertainty principle, Heisenberg microscope.

Module ll: General formalism of Quantum Mechanics

Wave function, Eigen functions and eigen values, Postulates of Quantum Mechanics, Orthogonality, Normalization, Operators- position, momentum, energy and angular momentum, Expectation value, Hermitian operators: properties, Probability Density & Probability current density.

Module III: Schrodinger equation and its applications

Time dependent Schrodinger equation, interpretation of wave function, Ehrenfest theorem, Extension to three dimensions, Time independent Schrödinger equation, Stationary states, Admissibility conditions of wave function, general properties of one dimensional Schrödinger equation, Stationary states, Expectation values, Free particle problem, Particle in a box.

Module IV: Special Theory of Relativity

Inertial frame, Galilean covariance of Newton's second law, Inconsistency with electromagnetic theory, Michelson-Morley experiment, Interpretation of null results of Michelson-Morley experiment, Postulates of special theory of Relativity, Definition of interval, Minkowski space-time diagram, Lorentz transformation in (1+1) and (3+1) dimension for standard configuration, Relativity of simultaneity, Length contraction and time dilation and their consequences, Transformation of velocity and acceleration, Fizeau's experiment, Four vectors, Relativistic dynamics, Equivalence of mass and energy.
Dynamical variables and operators, Position and momentum operators, Fundamental commutation relation, Wave function and its probabilistic interpretation, Coordinate representation, Time-dependent Schrodinger equation, Probability current and conservation of probability, Time-independent Schrodinger equation,

References:

1. *Concepts of Modern Physics, Arthur Beiser, McGraw Hill edition*
2. *Introduction to Modern Physics, H.S. Mani and G.K. Mehta*
3. *Quantum Mechanics, G Aruldhas, Printice Hall India (2004)*
4. *Quantum Mechanics, A Konar, Decca students Library Publication Ist Ed.*
5. *Quantum Mechnics, Mathews and Venkitesan, Tata McGrawHills (2006)*

IMSC503PH Thermodynamics

Credits 3(3-1-0)

Module l: Introduction to thermodynamics

Equation of state for gases Equation of an ideal gas, behavior of real gases, Andrew's experiment on carbon dioxide,critical state, two phase region, intermolecular forces, van der Waals equation of state, van der Waals isotherms, critical constants, limitation of van der Waals equation. Zeroth law of thermodynamics Thermodynamic system, surroundings, variables, thermal equilibrium: zeroth law, thermodynamic equilibrium, thermodynamic processes, reversible and irreversible processes, equation of state, expansivity and compressibility.

Module ll: Laws of Thermodynamics

First laws of thermodynamics, Internal energy, heat, work, cyclic processes, first law, heat capacity, energy equation and difference of specific heat capacities, indicator diagram work done in reversible isothermal expansion of ideal gas, work done in reversible adiabatic expansion of ideal gas. Heat engines and second law of thermodynamics, Second law statements, heat engine, efficiency, Carnot's ideal heat engine, work done by the engine per cycle, reversibility, Carnot refrigerator, heat pump, Carnot theorem, absolute scale of temperature, Clausius- Clapeyron latent heat equation.

Module III: Entropy and thermodynamic relations

Entropy, principle of increase of entropy, entropy and unavailable energy, change in entropy in heat conduction, change in entropy in reversible and irreversible process, efficiency of Carnot cycle from TS diagram, entropy of an ideal gas, entropy and disorder. Thermodynamic relations, Maxwell's thermodynamic relations, TDS equations, energy equation, heat capacity equations, thermodynamic functions, third law of thermodynamics.

Module IV: Heat Transmission

Conduction and radiation Conduction, thermal conductivity, thermal conductivity of bad conductor Lee's disc experiment -thermal resistance, thermal radiation and its properties, fundamental definitions of energy flux, intensity and radiant emittance, Stefan's law, Stefan-Boltzmann law.

References:-

1. *Thermal and Statistical Physics, R.B. Singh, New Age Pub. (2010)*
2. *An introduction to thermodynamics by Y.V.C. Rao (New Age Pub.)*
3. *An introduction to Thermal Physics by D.V. Schroeder (Pearson Pub.)*
4. *Heat and thermodynamics by Mark W Zemansky, Richard H Dittman & Amit K Chattopadhyay. MCH New Delhi.*
5. *Thermodynamics and Statistical physics Brij Lal, N.Subrahmanyam and P S Hemne (S. Chand &Co, Multi colour edition 2007).*

IMSC504PH Statistical mechanics I

Credits 3(3-1-0)

Module l: Foundations of Statistical Mechanics

Ideas of probability – classical probability – statistical probability – the axioms of probability theory – independent events – counting the number of events – statistics and distributions – basic ideas of statistical mechanics - definition of the quantum state of the system

Module II: Statistical Physics

Black body radiation, Stefans-Boltzmann Law, Wein's displacement law, Microstates and macrostates, Phase space, density of states, mu space and Gamma space, principle of equal a priori probability, ergodic hypothesis, statistical equilibrium, ensemble, ensemble formulation of statistical mechanics, microcanonical, canonical and grand canonical ensemble, partition function, average energy of particle, equipartition theorem.

Module lll: Statistics of Identical Particles

Identical particles – symmetric and antisymmetric wavefunctions - bosons – fermions – calculating the partition function for identical particles – spin – identical particles localized on lattice sites.

Module IV: Statistical distributions

Maxwell Boltzmann, Fermi-Dirac and Bose-Einstein statistics, distribution laws, Maxwell Boltzmann, Fermi-Dirac and Bose-Einstein distribution.

References:-

1. *Thermal and Statistical Physics, R.B. Singh, New Age Pub. (2010)*
2. *An introduction to thermodynamics by Y.V.C. Rao (New Age Pub.)*
3. *Introductory Statistical Mechanics, R. Bowley & M.Sanchez, 2nd Edn. 2007, Oxford University Press, Indian Edition, (Chaptr 11& 12)*
4. *Heat and thermodynamics by Mark W Zemansky, Richard H Dittman & Amit K Chattopadhyay. MCH New Delhi.*
5. *Thermodynamics and Statistical physics Brij Lal, N.Subrahmanyam and P S Hemne (S. Chand &Co, Multi colour edition 2007).*
6. *Berkeley Physics Course Volume 5; Statistical Physics; Frederick Reif. McGraw Hill.*
7. *Statistical Mechanics, R.K. Pathria, Pergamon press, Oxford*

IMSC505PH Semiconductor Physics and solid state physics Lab

Credits 2(0-0-6)

1. Determination of Band gap of semiconductor
2. Study of Magnetoresistance in a semiconductor
3. Study of Hall effect in semiconductor
4. Verification of Wiedemann Franz law in metals
5. Study of thermo-electric effect
6. Study of ferroelectric transition
7. Study of Hysteresis loop in ferromagnets
8. Determination of Susceptibility in paramagnetic fluids Quinkes method
9. Electron spin resonance and determination of g-factor
10. X-ray diffraction to study crystal structure
11. Low temp setup to study superconductivity.

IMSC506PH Electronics Lab

Credits 2(0-0-6)

1. Half Wave rectifier
2. Full Wave rectifier
3. Zener characterisitcs
4. Transistor Characteristics
5. FET Characteristics
6. Voltage regulators using Zener diode
7. LC Oscillator
8. Phase Shift Oscillator
9. OPAMP Characteristics

Reference books forPracticals

1. *Properties of Matter,D S Mathur*
2. *Practical Physics, P R Sasikumar Eastern Eco. Ed.*
3. *Advance level Practical Physics IV Ed., Nelkon and J M Ogborn*
4. *Advance course in Practical physics, D Chathopathyaya*
5. *Practical Physics,C L Arora*
6. *Electronics Lab Manuel, K A Navas*
7. *Digital fundamentals,Thomas L Floyed*
8. *A course of experiments with He-Ne Laser, R S Sirohi*
9. *Laboratory manael for introductory Electronic experiments, L K Maheswari & Nm S Anand*

IMSC601PH Solid State Physics-I

Credits 3(3-1-0)

Module I: Crystal structure

Solid state, crystalline, polycrystalline and amorphous materials, crystal lattice, periodicity, translation vectors, unit cell, basis, symmetry operations, bravais lattice in two and three dimensions, miller indices, interplanar spacing, simple crystal structures-hcp, fcc, bcc and simple cubic, Structures of NaCl, Diamond and ZnS, X-ray diffraction from crystals- Bragg's law, powder method, reciprocal lattice-properties, reciprocal lattice to sc, bcc and fcc, Bragg's law in reciprocal lattice. Inter-atomic forces, ionic bonding, bond dissociation and cohesive energy, madelung energy, covalent bonding, metallic bonding, hydrogen bonding, van derwaals bonding (basic ideas only).

Module II: Band Theory of Semiconductors

Free electron gas in one dimension, three dimension, electronic specific heat, band theory, Bloch theorem, Kronig-Penney model (derivation not expected), energy-wave vector relations, different zone schemes, velocity and effective mass of electron, distinction between metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, drift velocity, mobility and conductivity of intrinsic semiconductors, carrier concentration and Fermi level for intrinsic semiconductor, carrier concentration, conductivity and Fermi level for extrinsic semiconductor. Hall Effect, Direct and Indirect band gap, Principles of LED and Photodiodes.

Module III: Dielectric and Magnetic properties of materials

Polarization and susceptibility, local filed, dielectric constant and polarizability, sources of polarizability, Clausius-Mossoti relation, piezoelectricity.

Response of materials to magnetic field, classification of magnetic materials, Langevin's classical theory of diamagnetism and paramagnetism, ferromagnetism, Weiss theory, domain theory, antiferromagnetism and ferrimagnetism.

Module IV: Superconductivity

Origin of superconductivity, response of magnetic field, Meissner effect, super current and penetration depth, critical field and critical temperature, type-I and type –II superconductors, thermodynamic and optical properties, isotope effect, Josephson effect and tunneling- SQUID BCS theory-Cooper pairs-Existence of bandgap

References:-

1. *Solid State Physics by Puri and Babbar (S.Chand)*
2. *Solid State Physics, M.A. Wahab, (2ndEdition), Narosa*
3. *Introduction to Solid State Physics, Charles Kittel, (7thEdition), Wiley)*
4. *Crystallography applied to solid state Physics, AR Verma, ON Srivastava, New age*
5. *Solid State Physics, AJ Dekker- Macmillian.*
6. *Solid State Physics, NW Ashcroft, ND Mermin – Cengage Learning.*
7. *Elementary Solid State Physics, M. Ali Omer, Pearson.*
8. *Solid state physics, R L Singal, KNRN &Co.*
9. *Solid state physics, S O Pillai, New age*

IMSC602PH Spectroscopy-I

Credits 3(3-1-0)

Module l: Atomic Spectroscopy

Historical introduction. Electromagnetic spectrum. Types of spectra. Absorption and emission of light by atoms, quantum theory, early atom models – Bohr model, electron spin and magnetic moment, Exclusion principle, Stern-Gerlach experiment, Vector atom model, quantum numbers associated with vector atom models, Total angular momentum and LS coupling, fine structure of Sodium D lines, Zeeman effect, quantum mechanical explanation for anomalous Zeeman effect, Paschen-Back effect.

Module ll: Molecular Spectroscopy:

Molecular energy levels. Electronic, rotational and vibrational energies, rotational spectra, explanation in terms of rigid rotator model, vibrational energy levels, explanation in terms of harmonic oscillator.

Module lll: Electronic Spectroscopy
Electronic energy levels of atoms, Fluorescence and phosphorescence, Raman effect – experimental arrangement and result, classical theory and its failure, quantum theory of Raman effect.

Module IV: Spin Resonance Spectroscopy
NMR and ESR Spectroscopy NMR Spectroscopy- Basic principles and instrumentation- Medical applications of NMR.

References:-

1. *Molecular structure and Spectroscopy, G Aruldas.*
2. *Concepts of modern Physics, Arthur Beiser*
3. *Fundamentals olf Molecular Spectroscopy, C.Banwell and E. Mccash.*
4. *Molecular structure and Spectroscopy, G Aruldas.*
5. *Modern Physics, Kenneth S Krane (2ndEdition) -Wiley.*
6. *Concepts of modern Physics, Arthur Beiser (6thEdition) - SIE.*
7. *Spectroscopy: Straughan and Walker –(Vol.1) John Wiley*
8. *Fundamentals of Molecular Spectroscopy: CN Banwell –(4thedition) TMH .*
9. *Introduction to Atomic Spectra, HE White, TMH*
10. *Elements of spectroscopy, Guptha, Kumar and Sharma (Pragathi Prakash)*

IMSC603PH Nuclear and Particle Physics-I

Credits 3(3-1-0)

Module I: Nuclear structure & General Properties of Nuclei
Nuclear structure, Nuclear composition – Discovery of neutron – Nuclear electrons - Nuclear properties: Nuclear radii – Spin and magnetic moment - Stable nuclei - Binding energy- Binding energy curve, Liquid drop model - Semi empirical binding energy formula with correction factors – Essential idea of Shell model - Nuclear forces
Nuclear Radiation Detectors, - Ionization chamber - Solid state detectors - Proportional counter - Geiger-Muller counter - The Wilson cloud chamber - Bubble chamber

Module II: Radioactivity
Natural radioactivity–Alpha, Beta and Gamma Rays- properties, Gamow's Theory of alpha decay, Beta decay- Neutrino theory, origin of Gamma rays, nuclear isomerism, internal conversion, Mossbauer effect, Soddy Fajan's displacement law, Radioactive series, Law of radioactive disintegration, Mean life, measurement of decay constants, units of radioactivity, Radioactive dating, Artificial radioactivity, Applications of radioisotopes. Gamma decay - The concept of interaction cross section, reaction rate, Radiation Hazards

Module III: Nuclear Fission and Fusion
Nuclear fission, Energy released in fission, Bohr-Wheeler's theory, Chain reaction, Atom bomb, Nuclear reactors, Breeder reactors, Nuclear fusion, Sources of stellar energy, Thermonuclear reactions, Fusion reactors

Module IV: Particle Physics
Particle Physics Interactions and Particles – Leptons – Neutrinos and Antineutrinos, other leptons –Hadrons – Resonance particles – Elementary particle quantum numbers – Basic concepts of symmetries and conservation principles – Basic concepts of Quarks – color,flavor, Quark confinement – Higgs boson, Particle accelerators - Van de Graff generator, linear accelerator, cyclotron and Betatron.

Module V: Elementary Particles
Elementary particles, classifications, particles and antiparticles, antimatter, fundamental interactions, Elementary particle quantum numbers, conservation law and symmetry. Quark model (basic idea only).
Particle accelerators - Van de Graff generator, linear accelerator, cyclotron and Betatron.

References:-

1. *Concepts of Modern Physics, Arthur Beiser, 6th Edition, Tata McGraw-Hill publishing company*
2. *Text Book: Modern Physics, R. Murukeshan, Er. Kiruthiga Sivaprasanth, S. Chand Publications, Chapters 5,27 and 29*
3. *Modern Physics, R Murugeshan and K. Sivaprasath, 15th Edition (Revised) (2010),S.Chand*
4. *Atomic and Nuclear Physics, S N Ghoshal, S.Chand.*
5. *Nuclear and Particle Physics S L Kakani and Subhra Kakani -Viva Books 2008*
6. *Elements of Nuclear Physics, M L Pandya and R P S Yadav, Kedar Nath Ram Nath*
7. *Modern Physics, Kennth Krane, 2ndEdition, Wiley India (Pvt) Ltd.*
8. *Modern Physics , G. Aruldhas and P. Rajagopal, Prentice-Hall India*
9. *An Introduction to Astrophysics, Baidyanath Basu, 2nd Edition, Prentice-Hall India*

IMSC604PH Advanced Physics Lab-1

Credits 3(0-0-6)

1. Determination of Plancks constant using photo electric effect
2. Study of atomic levels using Frank Hertz experiment
3. Study of Electron diffraction
4. Millikans oil drop experiment
5. Verification of Stefan-Boltzmann law
6. Joule-Thompson effect
7. Study of phase and group velocity
8. Determination of G
9. Verification of Coulombs law and determination of permittivity of air
10. Diode characteristics and bridge rectifier

IMSC605PH Advanced Physics Lab-2

Credits 3(0-0-6)

1. Transistor characteristics
2. Determination of e/m
3. Sensitivity of a Ballistic galvanometer
4. Determination of velocity of light
5. Prism Spectrometer
6. Study of Diffraction of light (single and double slit)
7. Grating spectrometer
8. Polarimeter - optical activity
9. Newtons rings / Cornu interferometer
10. Michelson interferometer
11. Fabryperot interferometer

Reference books for Practicals

1. *Properties of Matter,D S Mathur*
2. *Practical Physics, P R Sasikumar Eastern Eco. Ed.*
3. *Advance level Practical Physics IV Ed., Nelkon and J M Ogborn*
4. *Advance course in Practical physics, D Chathopathyaya*
5. *Practical Physics,C L Arora*
6. *Electronics Lab Manuel , K A Navas*
7. *Digital fundamentals,Thomas L Floyed*
8. *A course of experiments with He-Ne Laser, R S Sirohi*
9. *Laboratory manael for introductory Electronic experiments, L K Maheswari & Nm S Anand*
10. *Optics, N Subramanyan, Brij Lal 7 Avadhanalu*

Physics Major (Elective Courses)

IMSE408PH-1 Electricity and Elecrodynamics

Credits 2(2-1-0)

Module I: Electrostatics

Review (Scalar and vector fields, Gradient, divergence, Curl and their physical significance). Charges and forces; Charge quantization; Coulomb's law, Electric field, Electric potential, Application of Coulomb's law to determine the potential and field due to one, two and three-dimensional charge distributions, Electric dipole and quadrupole, Gauss's theorem and its applications, Electrostatic energy Electrostatics in a dielectric medium, Capacitors, calculation of capacitance of parallel plate, cylindrical and spherical capacitors, Capacitors in parallel and series Moving charges and electric currents, current density, Ohm's law, Kirchhoff's law

Module II: Magnetostatics

Lorentz force law, Magnetic force due to line current, surface current and volume current, The Biot-Savart law, The divergence and Curl of B, Ampere's law and applications, Magnetic vector potential, Comparison of electrostatics and magnetostatics.

Module III: Electrodynamics, Maxwell's equation & Electromagnetic Waves

Ohms law, electromotive force, motional emf, electromagnetic induction, induced electric field, Maxwell's equations, Conservation laws, charge and energy, continuity equation, Poyntings theorem, Electromagnetic waves in vacuum-wave equations for E and B monochromatic plane waves-energy and momentum of electromagnetic waves.

Module IV:Alternating Currents & Network Theorems

EMF induced in a coil rotating in a magnetic field, Analysis of LCR series circuits, LCR parallel resonant circuit, comparison, Power in ac circuits, Wattless current, choke coil transformer, skin effect. Ideal voltage source and current source, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem.

References:

1. *Fundamentals of Physics, Resnick, Halliday and Walker, 6th edition, Wiley*
2. *University Physics, Sears and Zemansky, 10th edition, Addison – Wesley series*
3. *Introduction to electrodynamics, D.J. Griffiths, 3rd edition, Prentice Hall*
4. *Electricity and magnetism, A.S. Mahajan and A. A. Rangwala, McGraw Hill*
5. *Electricity & Magnetism, D N Vasudeva, S.Chand & Co.(2002)*
6. *Basic Electrical Engineering, Theraja, S.Chand & Co. (2000)*

IMSE408PH-2 Basic Electronics

Credits2(2-1-0)

Module I: Semiconductor Diodes and Applications

PN Junction, Depletion layer, Barrier potential, Biasing- forward and reverse, Reverse breakdown, Junction capacitance and diffusion capacitance- PN Junction diode – V-I characteristics–Diode parameters, Diode current Equation, Diode testing, Ideal diode.

Zener diode and its reverse characteristics. Thermistors. Rectification - Half wave, Full wave, Centre tapped, Bridge rectifier circuits - Nature of rectified output, Efficiency & Ripple factor-Filter circuits – Inductor Filter, Capacitor Filter, LC Filter, π Filter-Regulated Power supplies - Zener diode voltage regulatorVoltage multipliers – Doubler & Tripler- Wave shaping circuits - Clipper-Positive, negative and biased – Clampers- Positive, negative and biased.

Module II:Transistors

Bipolar junction transistors, Transistor biasing, CB, CC, CE configurations and their characteristics- Active, saturation and cut-off regions. Current gain α, β, γ and their relationships. Leakage currents- Thermal runaway. DC operating point and AC and DC Load line, Q-Point. Basic principles of feedback, positive & negative feedback, Advantages of negative feedback, negative feedback circuits – voltage series & shunt, current series & shunt.

Module III: Amplifiers and Oscillators

Introduction to amplification, CE amplifier – analysis of CE amplifier, CE amplifier parameters, Principle of feedback amplifiers, Positive and Negative feedback and its effect, Types of feedback connections (block diagram only), Emitter follower. Need for biasing-Stabilization- Voltage divider bias. Variations in Amplifier gain with frequency. Oscillatory Circuits, LC oscillators – Hartley Oscillator, Colpit's Oscillator, RC oscillators - Phase shift Oscillator. Astable and monostable multivibrator (basic idea only)

Module IV: Operational Amplifiers

Introduction, Symbols and terminals, Op-Amp Supply Voltage, Op-Amp Parameters, Op Amp as a voltage amplifier, Ideal Op amp, Op-amp circuits- inverting, non-inverting, voltage follower, summing amplifier, integrator, differentiator

References:-

1. *Basic Electronics-B.L.Theraja*
2. *Text Book of Applied Electronics-R.S.Sedha*
3. *Principles of electronics, VK Mehta, S Chand*
4. *Basic Electronics(7thEdition), Malvino and Bates, TMH*
5. *Electronics Fundamentals & Applications- D. Chattopadhyay & P.G.Rakshit, New Age Int. Publishers.*
6. *Electronics: Fundamentals of Analog circuits, Thomas L. Floyd, David Buchla, Prentice Hall*
7. *Electronic Devices and Circuit Theory, Robert Boylestad, Louis Nashelsky, Prentice Hall*
8. *Basic Electronics, Debashis De , Pearson 2010*

IMSE408PH-3 Smart Materials and Soft Matter

Credits 2(2-1-0)

Module I: Introduction to Smart Materials.

Classification of Smart Materials.According to their Response and Stimuli ability. Learning from nature - Biomimetricy. Fundamentals of Crystalline Structures in Smart Materials. Piezoceramic materials, magnetostrictive materials, shape memory alloys, electrorheologicalfluids, magneto-rheological fluids. Mechanics of structures with smart materials, passive and active vibration control. Principles of actuators and sensors. Case studies to demonstrate the application of smart materials. Microstructure.

Module II: Piezoelectric and Electrostrictivematerials,-

Describe the dielectric behaviour and the polarization mechanisms.- Describe the piezoelectric, ferroelectricand pyroelectric effect.- Determine the roperties of apiezoelectric material.. Magnetostrictive and Magnetoelectric materials.- Describe magnetic domains and domainwalls.- Identify ferromagnetic, paramagnetic and diamagnetic behavior

Module III: Introduction to soft condensed matter

Complex fluids, including polymers, colloids, liquid crystals, and biological structures. Emphasis on physical principles that govern bulk behavior. Consider phenomena strongly influenced by surface tensions, high curvatures, thin films, diffusion, adsorption, wetting, which are variously mobile, dynamic, polymeric, transient, fragile. Emphasis on the physics, thermodynamics, rheological and scaling laws that govern bulk behavior.

References

1. *Introduction to soft matter; synthetic & biological self-assembling materials,Hamley, I.W.John Wiley & Sons.*
2. *From: Chemistry and Industryby Sage, Dr. Ian Chichester: John Wiley & Sons, 2000*
3. *Functional and Smart Materials: Structural Evolution and Structure Analysis by Zhong-lin Wang, Z.C. Kang*

IMSE408PH-4 Materials Science and Engineering

Credits 2(2-1-0)

Module I: Historical perspective of Materials Science.

Classification of materials. Advanced Materials, Future materials and modern materials. Crystal structures, Crystalline and noncrystalline materials. Miller indices. Anisotropic elasticity. Elastic behavior of composites. Structure and properties of polymers. Structure and properties of ceramics.

Module II: Imperfections in Solids

Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations Mechanical Properties of Metals; Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yielding under multiaxial stress. Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors.

Module III: Diffusion processes and their Industrial Applications

Phase diagrams: Gibbs phase rule, zone refining and pure Si crystals, First and Second order phase transitions; martensitic transformation and spinodal decomposition; Electrical and thermal behaviour; solid solutions and Nordheim's rule,Skin effect, thin metal films and integrated circuit inter-connections; thermoelectricity, seebeck, Thomson and Peltier effects, thermoelectric heating and refrigeration, thermoelectric generators, the figure of merit; Elastic behaviour of solids, Anelasticity, thermoelasticity, viscoelastic deformation, Corrosion and Degradation of Materials: Electrochemical considerations, corrosion environments, corrosion prevention.

References

1. *D. Jiles, Introduction to the Electronic Properties of Materials, 2nd Ed.,2010, Nelson Thornes Ltd.*
2. *G. Gottstein, Physical Foundations of Materials Science, Springer (2004).*
3. R. Hoffmann, Solids and Surfaces: A chemist's view of bonding in extended *structures, Wiley-VCH, 1988.*
4. *N.W. Ashcroft and N. D. Mermin, Solid State Physics, Brooks-Cole (1976).*
5. *5 . S. Elliot, The Physics and Chemistry of Solids, Wiley India (1998).*
6. *Materials Science and engineering ; An introduction, William D callister, John wiley*
7. *The nature and properties of engineering materials, J.D Jastrzebski, John Wiley*

IMSE507PH-1 Relativity, Astronomy and Astro Physics

Credits 2(2-1-0)

Module 1: Special Theory of Relativity

Inertial and non inertial frames of reference- Galilean transformation, Significance of Michelson-Morley experiment, Postulates of Special Theory of Relativity, Lorentz transformation, Spatial contraction, Time dilation, composition of velocities, mass of moving particle, Equivalence of mass and energy. Introductory concept of general theory of relativity.

Module II: Observational Astronomy

Observational astronomy, Astronomical distance scales – AU, Parsec and light year. Stellar Parallax and distance to stars from parallax. Magnitude scale - Apparent and absolute magnitudes. Variable stars as distance indicators. Cepheid variables. Astronomy in different bands of electromagnetic radiation- Optical, radio and X-ray astronomies, Radiation Laws. Optical Telescopes. Types of telescopes-refracting and reflecting – Newtonian and Cassegrain telescopes. Magnification and f number. Resolving Power, Telescope mounts – alt-azimuth and equatorial mounts.

Module lll: Solar System

Concept of celestial sphere - cardinal points, celestial equator, ecliptic, equinoxes. Diurnal motion of sun - summer solstice and winter solstice. Celestial co-ordinate systems: – Horizon system – Azimuth & Altitude, Equatorial system-Right ascension & declination, Ecliptic coordinate system.Time - apparent and mean solar time, sidereal time. Twilight, Seasons- causes of seasons (qualitative ideas). International Date Line. Sun Sun - solar atmosphere and internal structure – Photosphere, chromosphere and corona. Radiation zone & Convection Zone. Sun spots, Activity Cycles, flares, prominences, coronal holes, Solar wind.

Module IV: Astrophysics

Galaxies - our galaxy, galaxy types & turning fork diagram. Structure on the largest scale- clusters, super clusters and voids. Gravitational contraction - Virial theorem, Jeans mass. Energy production inside stars. Thermonuclear fusion. Hydrogen burning. p-p chain. CNO cycle. Evolution of stars – birth – protostar, hydrostatic equilibrium, red giant, late stages of evolution - white dwarfs & Chandrasekhar limit, Neutron stars, Supernovae, Pulsars, Black holes. Stellar Classification, H-R diagram - Main sequence stars Cosmology Large scale structure of the universe – isotropy and homogeneity.

Cosmological principle. Standard big bang model - GUT, Planck Epoch, Inflation, Nucleosynthesis, Recombination & CMBR. Expanding universe - red shift. Hubble's law and Hubble parameter. Age of universe and its determination. Dark energy and Dark Matter (qualitative idea).

References:-

1. *Astophysics, Stars and Galaxies, K D Abhyankar Section 3.1 & 4.3, Ian Morison*
2. *Dinah L. Moché, Chapter 4, Ian Morison Chapter 2*
3. *Modern Physics, Kenneth S Krane.*
4. *Concepts of modern Physics, Arthur Beiser*
5. *A short history of the Universe – Joseph Silk*
6. *Introduction to Astronomy and Cosmology, Ian Morison, John Wiley & Sons, Inc.*
7. *ASTRONOMY, A Self-Teaching Guide, Dinah L. Moché, John Wiley & Sons, Inc.*
8. *Introduction to cosmology- J V Narlikar*
9. *http://www.astro.cornell.edu/academics/courses/astro201/topics.html http://www.ualberta.ca/~pogosyan/teaching/ASTRO_122/lectures/lectures.html , http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html*

IMSE507PH-2 Digital Electronics and Programming

Credits 2(2-1-0)

Module I: Number Systems and Boolean Algebra

Review of Number Systems, Subtraction with 2's complement and 1's complement, BCD Code.Binary logic- AND, OR and NOT operators- Logic symbol and truth table-Laws of Boolean algebra-Demorgan's theorem- Duality theorem- Boolean functions- Complement of a function- Conversion between truth table, Boolean expressions and Logic diagrams, NAND, NOR, XOR, XNOR gates

Module II: Combinational Logic Circuits

Adders- Half and Full adders- Half and Full Subtractor, Four bit parallel adder, Subtractor, Decoders- 3-to – 8 decoder, Encoders- Octal –to- binary encoder

Module III: Sequential Logic Circuits

Flip-flops, RS, Clocked RS, MSJK FF, DFF JK, Buffer registers- Shift register, D/A converters (Ladder type)

Module IV: Numerical Methods and Programming

Iteration principle, Newton-Raphson methods, numerical integration-trapezoidal rule and Simpson's 1/3 rule, Numerical solution of differential equation- Euler's method, second order Runge-Kutta method.

C++ programming basics - preprocessor directives-declarations and definitions-manipulators-arithmetic operators-library functions- loops and decisions- for loop, while loop, do loop, if, if…else, else if, switch statements , conditional operator, logical operators, break statement, continue statement, go to statement.Functions (qualitative only)

Algorithm and program development using C^{++}

1. Newton-Raphson methods
2. Runge-Kutta Method
3. Euler's method
4. Trapezoidal Rule

References:

1. *Digital circuits and design- S Salivahanan and S ArivazhakanPHI*
2. *Digital design- M Morris Mano PHI Chapter 1,2 and 3*
3. *Digital Fundamentals – Floyd- Thomas L Floyd*
4. *Digital design- M Morris Mano PHI Chapter 2 and 3*

IMSE507PH-3 Electronics II

2 Credits(2-1-0)

Module I: **FETS**

characteristics, small signal model, common source and commondrain amplifiers, biasing; MOSFET. Silicon controlled rectifiers, SCS, Diac, Triac, characteristics and applications; Operational amplifiers-

actual circuits of operational amplifiers, uses as amplifiers, analog circuits adding, integration and differential circuits, comparators, waveform generators,logarithmic generators.

Module II:Binary Number Systems
binary-decimal conversions,hexadecimal and Octal numbers, BCD, Gray code, ASCII code; Boolean algebra, Laws of Boolean algebra, De Morgans theorem, Simplification of Boolean expressions, Karnaugh Map; Logic gates, combinational logiccircuits, deriving the truth table, designing combinational logic from truth table. NAND and NOR gates; Half adder, full adder, look-ahead-carry implementation, Magnitude comparators, decoders, encoders multiplexers, demultiplexers.

Module III: **Flip-flops**
- RS, D, JK flip-flops, multivibrators. Synchronous and asynchronous counters, counter applications, Shift registers, different types, shift register applications, D/A and A/D conversions; Memories ROM, PROMand EPROM, RAM, special memories and applications. Integrated circuits, CMOS, PMOS and NMOS; Microprocessors architecture, addressing modes, 8085, 8086 microprocessors, peripheral devices, microcontrollers.

References:

1. *A. Malvino and D. J. Bates, Electronic principles, Mcgraw-hill, 2006.*
2. *J. Millman, C. C. Halkias and S. Jit, Electronic devices and circuits, Tata Macgraw Hill, 2007.*
3. *J. Millman, and C. C. Halkias, Integrated electronics, Tata Macgraw Hill 2008.*
4. *S. M. Sze, Semiconductor Devices, Physics and Technology (2nd Ed.),WileyIndia, 2008.*
5. *T. L. Floyd and R. P. Jain, Digital Fundamentals (8th Ed.), Pearson Education,2005.*
6. *M. Morris Mano and M. D. Ciletty, Digital Design (4th Ed.), Pearson Education,2008.*
7. *R. S. Gaonkar, Microprocessor architecture, programming, and applications with 8085, Prentice Hall, 2002.*

IMSE606PH-1 Computational Physics

Credits 2(2-1-0)

Module l: Solutions of Nonlinear Equations
Bisection Method - Newton Raphson method (two equation solution) – Regula-Falsi Method, Secant method - Fixed point iteration method - Rate of convergence and comparisons of these Methods Solution of system of linear algebraic equations Gauss elimination method with pivoting strategies-Gauss-Jordan method-LU Factorization, Iterative methods (Jacobi method, Gauss-Seidel method)

Module ll : Curve Fitting and Interpolation
Regression and interpolation, Least squares square method of fitting a straight line, parabola, polynomial and exponential curve, Finite difference operators-forward differences, divided difference; shift, average and differential operators- Newton's forward difference interpolation formulae- Lagrange interpolation polynomial- Newton's divided difference interpolation polynomial.

Module lll :Numerical Differentiation and Integration
Numerical Differentiation formulae, cubic spline method, Maxima and minima of a tabulated function, Newton Cote general quadrature formula, Trapezoidal, Simpson's 1/3, 3/8 rule and error associated with each, Romberg's integration, Gaussian integration method, Monte Carlo evaluation of integrals, numerical double integration.

Module IV: Numerical Solution of ordinary differential equations
Taylor Series Method, Picard's method-Euler's and modified Euler's method –Heun's method-Runge Kutta methods for 1st and 2nd order

Module V: Numerical solutions of partial differential equations
Elementary ideas and basic concepts in finite difference method, general solution of second order linear partial differential equations-elliptic equation.

References:-

1. *Numerical Methods, Balagurusamy, TMH*
2. *Numerical Methods for Scientists and Engineers- K Sankara Rao- PHI*
3. *Introductory Numerical Methods, S S Sastry, PHI.*

IMSE606PH-2 Fundamentals of Lasers and Fibre optics

Credits 2(2-1-0)

Module l: Fundamentals of Lasers

Absorption and emission of light-Absorption-spontaneous emission and Stimulated emission, Einstein relations, Population inversion- Active medium-Pumping, different pumping methods, Resonators – plane mirror and confocal resonators – Metastable state, Three level and Four level Laser systems. Ruby Laser, He-Ne laser,Semiconductor Laser, Laser beam Characteristics, coherence. Applications of Laser, Holography (qualitative study only).

Module ll : Optical Waveguides

Ray theory theory of transmission - Total internal reflection -Acceptance angle - Numerical aperture - Skew Rays. EM Theory for Optical propagation – Modes in a planar waveguide –Phase velocity and group velocity – Evanescent field –

Module lll: Fibre Optics

Optical fiber as a cylindrical waveguide- Modes – Mode coupling (elementary idea) – Classification of fibers – Step index fiber – Graded index fiber – Single mode fiber – Number of modes and cut off parameters – Mode field diameter and spot size

Module IV: Transmission Characteristics of Optical Fibers

Attenuation – Absorption losses – Linear scattering losses – Nonlinear scattering losses – Wavelengths for Communication – Fiber bend loss – Dispersion effects in fibers - Intra modal dispersion – Inter modal dispersion,

Module V: Fiber Optic Communication

Fibre optic communication system- Advantages of fiber optic system - System design considerations for point to point links- Digital systems- Link power budget- Rise time budget- Line coding- Analog systems- System architecture- Point to point links- Distribution networks- Local area networks

References:-

1. *Semiconductor physics and optoelectronics- V.Rajendran, J.Hemaletha and M.S.M.Gibson*
2. *Optical Fiber Communications, John M. Senior,PHI*
3. *Fiber Optics and Optoelectronics, R.P. Khare, Oxford University Press*
4. *Optics, E Hecht and AR Ganesan, Pearson*
5. *Optical Electronics, AjoyGhatak and K Thyagarajan, Cambridge*
6. *Optics and Atomic Physics, D P Khandelwal, Himalaya Pub. House*
7. *Optics, S K Srivastava, CBS Pub. N Delhi*
8. *Optics N.Subramanayam, Brijlal, M.N Avadhanulu S Chand.*
9. *Semiconductor optoelectronic devices: Pallab Bhattacharya, PHI 2009.*
10. *Lasers and Non linear Optics, BB Laud, New Age Int Pub. 2013*
11. *Laser Fundamentals, William T Silfvast, Cambridge Univ Press. 2012.*
12. *Fiber Optics and Optoelectronics, R P Khare, Oxford 2012.*

IMSE606PH-3 Non Linear Optics & Laser Physics)

Credits 2(2-1-0)

Module I: Introduction to Nonlinear Optics

Optics & Wave propagation in anisotropic medium,Electromagnetic Waves in Nonlinear Media, Phenomenological theory of nonlinearities, Nonlinear polarization. Second Order Nonlinear Optics: Electro-Optic and Acousto-optic effects, Acousto-optic Modulators, Harmonic generation, Phase Matching, Parametric Effects, Photorefractive Effect.

Module II: Nonlinear Optical processes:

Wave Mixing; Nonlinear Refraction and Absorption, Multiphoton Processes, Self-focusing, Self-phase-modulation, Photon Echo, Optical Switching and Solitons. Stimulated Scattering: Rayleigh, Brillouin, and Raman Processes. Nonlinear optical Techniques & Materials: Z-Scan, Four-Wave Mixing, Third Harmonic Generation, Non-Linear Optics of Organics, Semiconductors, Glasses, Polymers, Fiber and Nanostructures.

Module III: Interaction of Radiation with Matter

Semi classical theory, stimulated emission, life times and line widths, Laser rate equations, gain coefficient, threshold conditions, gain saturation, optimum output coupling, cw and pulsed operation, pumping mechanism theory of optical resonator, longitudinal and transverse modes, Q switching, mode locking, pulse compression, different types of lasers, laser amplifier, applications of laser.

References

1. *Robert W. Boyd, Nonlinear Optics, Academic Press, New York, 1992.*
2. *Y. R. Shen, The Principles of Nonlinear Optics, New York, J. Wiley, 1984.*
3. *G S He & S H Liu, Physics of Nonlinear Optics, World Scientific, Singapore, 2000.*
4. *P.N. Butcher and D. Cotter, The Elements of Nonlinear Optics, Cambridge Univ. Press,New York, 1990*
5. *A. Yariv, Optical Electronics in Modern Communications, Oxford University Press, 1997.*
6. *A. K. Ghatak & K. Thyagarajan, Optical Electronics, Cambridge University Press,(1991)*
7. *R.L. Sutherland, Handbook of Nonlinear Optics, Marcel Dekker Inc., 2003.*
8. *O. Svelto, Principles of Laser, Plenum (1998).*
9. *W. T. Silfvast, Laser and Fundamentals, Cambridge (1996).*
10. *A. Yariv, Quantum Electronics, John Wiley (1988).*

IMSE606PH-4 High Energy Physics

Credits 2(2-1-0)

Module I: Introduction

Units energy, momentum and mass; Cross-Sections: Total and partial cross-sections, Differential cross-sections, Elastic scattering, Form factor F(q), Born approximation, Fourier relationship between _(r) and F(q); Relativistic Kinematics: 4-vectors P = (p; iE), 4-momentum transfer, q, Lorenz Invariant Phase space. Classification of Particles:Fermions and bosons - constituents of matter and fields, Introduction to the Standard Model, Leptons and quarks; Interactions and Fields:Exchange bosons, The 4 fundamental forces their ranges and relative strengths, Feynman diagrams, Virtual particles, Yukawa potential.

Module II:Invariance Principles and Conservation Laws

Origin of conservation laws, properties of space-time, Conservation of p, E and L, Global phase or gauge transformations, Properties of the gauge groups U(1), SU(2) and SU(3) (Additive and) multiplicative conservation laws, charge conjugation (C), parity (P) and time-reversal (T) symmetries, CPT theorem.

Module III:Fundamental Interactions

Electromagnetic - QED, electron self-energy, vacuum polarisation, renormalisation. Magnetic moments, g2 experiment and theory;Weak -Low energies, beta decay,W+,W. High energy divergences and electroweak unification, Z0. e+ e annihilation experiments, number of fermion generations, partity violation; Strong - QCD, quarks and gluons, colour, _s (running), Allowed hadrons, hadronisation and jets. Properties of Quarks: Isospin & strangeness, charm, beauty (bottom), top,Quark content of hadrons, Strangeness regeneration. e+ e- scattering and annihilation, time-like and space-like virtual photons, R and colour factor, Deep inelastic scattering, scaling, Jets and gluon bremsstrahlung;

Module IV:Experimentation for Particle Physics

Principles of Particle Detectors, Interaction of particles with matter, gaseous detectors, scintillators and photon detectors, tracking of charged particles; principles of calorimetry; data acquisition and triggering; examples of existing detectors and detector performance.

References

1. *Donald H. Perkins, Introduction to High Energy Physics, Addison-Wesley.*
2. *F. Halzen and A. D. Martin, Quarks and Leptons: An Introductory Course in Modern Particle Physics, Wiley.*
3. *D. J. Griffiths, Introduction to Elementary Particles, Wiley.*
4. *I. S. Hughes, Elementary Particles, Cambridge.*

Biology Major (Core Courses)

IMSC406LS Animal Diversity Lab

Credits 2(0-0-6)

1. General identification of the following animals (two representatives from each) by their scientific names. Protists, sponges, coelenterates, flat worms (free living & parasitic), parasitic nematodes, economically important crustaceans, insect vectors/pests, economically important molluscs, echinoderms, common food fishes of Kerala (marine & fresh water), common amphibians of Kerala, snakes of Kerala (Nonpoisonous & Poisonous), rodents.
2. Study the beak and feet modifications in the following birds - duck, parrot, king fisher, owl, kite and wood pecker.
3. Taxonomic identification using keys (five specimens each):-
   a. Identification of insects up to the level of order
   b. Identification of fishes up to the level of order.
   c. Identification of snakes up to family.
4. Scientific Drawing –
   a. Make scientific drawings of 10 locally available specimens (5 invertebrates + 5 vertebrates) belonging to different phyla.
5. Study the following using temporary/permanent slides
   a. Mouth parts –House fly, Honey bee, Mosquito
   b. Neries – Parapodia
   c. Cockroach - Salivary glands
   d. Fish scales – Placoid,cycloid,ctenoid
6. Laboratory Record

References

1. Sathe, T.V., 2005. Basic entomology: a practical manual. Basic entomology: a practical manual.

2. Verma, P.S., 2000. A Manual of Practical Zoology: Chordates. S. Chand Publishing.

IMSC407LS Plant Diversity Lab

Credits 2(0-0-6)

I. Identify the following types by making suitable micropreperations and make labelled sketches.

1. Spirogyra, 2. Rhizopus, 3. Puccinia, 4. Riccia, 5. Pteris, 6. Cycas

II. Family Studies

1. Annonaceae, 2. Malvaceae, 3. Leguminosae, 4. Rubiaceae,
5. Compositae,6. Ascipediaceae, 7. Euphorbiaceae,8. Poaceae

Laboratory Record

References

1.Dayananda, B. (1999). Experiments in Plant Physiology, Narosa Publishing House, New Delhi.

2. ColRuxton R, S N. Colegrave.2006.Experimental Design for the life Science, Oxford University Press

3. Johnson DA, 1940. Plant Microtechnique, McGraw Hill Co., New York.

IMSC501LS Animal Physiology

Credits 3(3-1-0)

ModuleI:Metabolism

Basal metabolism- calculation of BMR by Harris-Benedict formula; Energy metabolism- (a)Carbohydrate metabolism – glycolysis, glycogenolysis, glycogenesis, glucogenesis, gluconeogenesis, Pentose Phosphate pathway), Kreb's cycle; Electron Transport System (ETS) and oxidative phosphorylation.

(b)Protein metabolism- deamination, transamination, decarboxylation,transmethylation.

(c) Lipid metabolism – oxidation of glycerol and fatty acids (β oxidation); Biosynthesis of fatty acids

Module II:Respiration
Gas exchange, respiratory pigments- structure of haemoglobin,transport of Oxygen, Oxyhaemoglobin curve, Bohr effect, transport of CO2 - carbonic acid, carbamino haemoglobin, bicarbonate and chloride shift, regulation of respiration – neural and chemical

Module III: Cardio-vascular System
Heart - structure, myogenic, neurogenic heart, cardiac cycles, cardiac output, blood pressure, regulation of heart heartbeat, conducting system and pace maker, pulse, ECG - basis, principles of recording, significance
Blood - Composition and functions of blood plasma and formed elements, blood volume regulation, blood groups, mechanism of blood, disorders of blood clotting, anticoagulants
Lymph and lymphatic system (brief account)

Module IV: Muscle Physiology
Brief account on types of muscles. Ultra structure of striated muscle fibre, muscle proteins, simple muscle twitch, summation, tetanus, tonus, All or None law, fatigue, oxygen debt, rigor mortis.Physiological and biochemical events in muscle contraction.

Module V: Excretion
Nephron – Structure, Urine formation, Role of hormone in urine formation and concentration, Counter-current multiplier system,Role of kidney in osmoregulation, composition of urine, abnormal constituents of urine, regulation of kidney functions, renal disorders – nephritis, haematurea, renal calculi, acidosis and alkalosis, Dialysis.

Module VI:Nerve Physiology
Neurons – structure, types of neuron, Synapse and types of synapse, nerve impulse propagation, synaptic transmission. Reflex action, refractory period, neurotransmitters, electroencephalo gram. Nerve disorders – epilepsy, Alzheimer's disease, Parkinson's disease.

Module VII: Sensory Physiology
Structure of eye, Physiology of vision, visual elements and pigments, photochemistry of vision. Eye defects – myopia, hyperopia, presbyopia, astigmatism, cataract. Structure of ear and mechanism of hearing, hearing impairments, deafness. Olfactory, gustatory and tactile sense organs

Module VIII:Reproductive Physiology
Male and female reproductive organs, Reproductive Cycles(role of hormones), puberty, adolescence, pregnancy, parturition, lactation.

Module IX:Endocrinology
Endocrine glands in man, Hormones as messengers, hormones and disorders, feed back mechanism.

References

1. *Best and Taylor. 1990. Physiological basis of Medical Practice. Wilkins Co.*
2. *Ganong, W.F. 2003. Review of Medical Physiology, McGraw Hill, New Dellhi.*
3. *Guyton 2002: Text Book of Medical Physiology. Saunders pp.264-379*
4. *Hoar, W.S.1975. General and Comparative physiology. Prentice Hall. Longman Ltd., New Delhi.*
5. *Prosser, C.L. 1978. Comparative animal physiology. W.B.Saunders Co.*
6. *Sebastian, M.M. Animal Physiology. Dona Publications, Changanacherry.*
7. *Subramanyan, S. and Madhavankutty, K. 1977. The text book of physiology, Orient*
8. *Vander, A.J., Sherman, J.H. and Luciano D.S. 1998. Human Physiology, MacGra Hill Publishing Co. Delhi.*
9. *Withers P.C . 1992. Comparative animal physiology. Saunders College Publishing*

IMSC502LS Biophysical Techniques

Credits 3(3-1-0)

Module I: Microscopy
Principle and working of Light microscope, dark field microscope, Phase contrast microscope, Differential Interference contrast microscope, Polarizing microscope, Fluorescent microscope and Electron microscope (TEM & SEM)

Module II: Chromatography
Principle and working of paper chromatography, TLC, Gel filtration, affinity and Ion exchange chromatography, HPTLC, HPLC and GC.

Module III: Electrophoresis
Principle and working of moving boundary electrophoresis, zone electrophoresis, agarose gel electrophoresis, native PAGE, SDS-PAGE. Southern, Northern and, Western transfers, Isoelectric focusing, Capillary electrophoresis and DNA sequencing, Pulsed – field Electrophoresis

Module IV: Centrifugation
Principle and working of preparatory and analytical centrifuges, ultracentrifuges, factors affecting sedimentation velocity, sedimentation coefficient, measurement of S, Zonal centrifugation

Module V: Spectrophotometric Tecchniques
Principle and working of UV and visible Spectophotometry, IR and NMR Spectrophotometry. Principles of turbidimetry and nephelometry. Principle, instrumentation and application of luminometry. Atomic spectroscopy, Mass spectroscopy

Module VI: Isotope Tracer Technique
Types of radiations, measurement scintillation and gamma counters. Background noise quenching, Applications. Interaction of radiation with matter, passage of neutrons through, matter, interaction of gamma rays with matter, units of measuring radiation absorption, Radiation dosimetry, Radiolysis of water, free radicals in water. Autoradiography

Module VII: Immunological techniques
Principle and applications of Agglutination, Precipitation, ELISA-different types, Western Blotting, Radio Immuno Assay,

References

1. *Alonso, A., and Arrondo, J.L.R.2006. Advanced Techniques in Biophysics. Springer,UK.*
2. *Das, D. 1991. Biophysics and Biophysical Chemistry. Academic Publishers, Calcutta*
3. *Edward, A.L. 1997. Radiation Biophysics. Academic Press,NY,USA.*
4. *Ghatak K.L. 2011.Techniques and Methods in Biology. PHI Learning Pvt. Ltd. New Delhi.*
5. *Gupta A. 2009. Instrumentation and Bio-Analytical Techniques.Pragati Prakashan Meerut.*

IMSC503LS Research Methodology& Biostatistics

Credits 3(3-1-0)

Module I: Basic concepts of research
Meaning, Objectives, Approaches, Types of research, Scientific method in research (eight steps), Defining and formulating the research problem. Importance of literature reviewing in defining a problem, Identifying gap areas from literature review, Research Design: Basic principles and features of good design, Development of a research plan: Determining experimental and sample designs.

Module II: Research Communication and scientific documentation
Project proposal writing, Research report writing, Structure of a scientific paper, Thesis, dissertation, research article, Presentation techniques: Oral presentation techniques, Assignment, Seminar, Debate, Workshop, Colloquium, Conference, Sources of Information: Primary and secondary sources. Library-Books, Journals, Periodicals, Reference sources, Abstracting and indexing sources, Reviews, Internet, Search engines and software: Online libraries, e-Books, e-Encyclopedia, Institutional Websites.

Module III: Bioethics
Introduction, Animal rights and animal laws in India, Prevention of cruelty to animals Act 1960,Wildlife protection act 1972 and Amendments, Biodiversity Act 2003. Concept of 3 R – conservation (Refined- to minimize suffering, Reduced – to minimize animals, Replaced – modern tools and alternate means), Animal use in research and education: Laboratory animal use, care and welfare, Animal protection initiatives, Animal Welfare, Animal Welfare Board, India, CPCSEA, Working with human: Consent, harm, risk and benefits.

Module IV: Animal Collection Techniques
Brief account on Collection methods, techniques and equipments for Plankton, Insects, Fish, Bird, Preservation techniques: Different techniques for preservation of animals including taxidermy, Rearing techniques: Techniques in laboratory and on field.

BIOSTATISTICS

Module V: Sample and Sampling Techniques

Collection of data, Classification of data, Frequency distribution tables, Graphical representation of data: Bar diagrams, Histogram, Pie diagram and Frequency curves.

Module VI:Analysis of Data

Measures of Central Tendency: Mean, Median, Mode (Problem - Direct method only) Measures of dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation, Standard error. (Merits & demerits and problems on SD). Correlation: Definition, Types of correlation. (Brief account only). Test of Hypothesis and Test of Significance: Basic concept, Levels of significance, test of significance, Procedure for testing hypothesis, types of hypothesis- Null hypothesis and Alternate hypothesis. Statistical packages - SPSS, BIOSTAT, PRIMER. (Brief account only)

References

1. *Aggarwal. S.K. 2009. Foundation Course in Biology, 2nd Ed.. Ane's Student Edn Ane Books Pvt. Ltd.*
2. *Anderson, J, Durston, B.H. and Poole, M. 1992. Thesis and assignment writing. Wiley Eastern Ltd.*
3. *Campell, R. 1990. Statistics for biologists. CBS Publishers and distributors.*
4. *David. G. Kleinbaum and Mitchel Klein 2009. Survival analysis - Statistics forBiology & Health 2nd .Ed. Springer International ed.*
5. *Day, R.A. 1993. How to write and publish a scientific paper. Cambridge Univ.Press. (Module VI)*
6. *Debbies Holmes, Peter Moody and Diana Dine 2006. Research methods for theBiosciences. International student Edition : Oxford University Press .*
7. *Ernst Mayr 1982. The Growth of Biological Thought: Diversity, Evolution, and Inheritance. Published by Harvard University Press.*
8. *Gupta K.C, Bhamrah, H.S and G.S.Sandhu 2006.Research Techniques in BiologicalSciences. Dominant Publishers and Distributors, New Delhi.*
9. *Hawkins C. and Sorgi, M. 1987. Research: How to plan, speak and write about it.Narosa Publishing House.*
10. *Knudsen J. W.1966. Biological Techniques: Collecting, Preserving, and Illustrating Plants and Animals*

IMSC504LS Wildlife Biology

Credits 3(3-1-0)

Module I: Evaluation of Wildlife Habitat

Define habitat – Forest habitat types (mangroves, moist deciduous, dry deciduous, semi evergreen, evergreen, shola forests)

Module II:Wildlife Resources of India with special reference to Kerala

Definition of wildlife, Brief account of mammals, birds, herpetofauna, fishes, invertebrates of Kerala, IUCN status.

Module III:Human-Wildlife Conflicts

Basic concepts, reason for conflicts, Identification of damages caused by wild animals and control measures. Case studies – Elephant, gaur, wild boar, monkey, tiger and leopard, Translocation of Wild animals – Principles, Methods and application.Human wildlife co existence, traditional knowledge in wildlife conservation.

Module IV: Wildlife Management

Threats and conservation issues (poaching, habitat loss, habitat fragmentation and habitat degradation, roadside kills, alien species, pollution, other anthropogenic activities, endemism etc.). Population estimation of wildlife - Basic concepts and applications - Direct count (block count, transect methods, Point counts, visual encounter survey, waterhole survey). Indirect count (Call count, track and signs, pellet count, pugmark, camera trap, DNA finger printing and aerial photography).

Module V: Wildlife Conservation

Definition, In-situ and ex-situ conservation, formation, management and administration. Case studies (Silent Valley National Park, Chinnar Wildlife sanctuary, Salim Ali Bird sanctuary, Thattekkad,). Project Tiger – Project Elephant – Project Crocodile. Wildlife (Protection) Act.

References

1. *Daniel, J.C. 2002. The Book of Indian Reptiles & Amphibians, Oxford Univ. Press, Mumbai*
2. *Daniels, R.J. R. 2002. Freshwater Fishes of peninsular India. Universities press (India) Private Ltd. Hyderabad*
3. *Dasmann, RF. 1964. Wildlife Biology. John and Wiley and sons Newyork. P-231.*
4. *Giles, R.H. Jr. (Ed) 1984. Wildlife Management Techniques 3rd edition. The wildlife*
5. *Menon, V. 2003. A Field Guide to Indian Mammals. Dorling Kindersley (India) Pvt.Limited*
6. *Saharia, V.B. 1982. Wildlife in India, Nataraj Publishers, Dehra Dun*
7. *Seshadri, B.1986. India's Wildlife reserves , Sterling Pub'rs Pvt. Ltd., New Delhi*
8. *Thomas, A.P. (Ed) 2013. Biodiversity Scope&Challenges. Green leaf Publications,Kottayam*
9. *Tripheron, C.A. and Johnson, N.F. 2005. Borror and Delong's Introduction to the Study of Insects. Brooks/Cole Ceanage Learning Ltd.*

IMSC505LS Molecules of Living Systems, Plant/Animal Physiology-Lab

Credits 2(0-0-6)

Molecules of Living Systems

1. Qualitative Analysis.

A) Reactions of carbohydrates:

(i) General test for carbohydrates- Molisch's test.

(ii) Tests for monosaccharides (Glucose/fructose) – Benedict's test, Fehling's test, Moore's test, Rapid furfural test, Seliwanoff's test, Barfoed's test– (Any 3 tests).

(iii) Test for non-reducing disaccharides (Lactose/Sucrose)– Hydrolysis test.

(iv) Test for polysaccharide (Dextrin/Starch) – Lugol's iodine test.

B) Tests for proteins–Ninhydrin test, Biuret test, Nitric acid test, Millon's test, Sodium nitroprusside test – (Any 3 tests).

C) Tests for lipids – Solubility test, Spot test, Acrolein test, Emulsification test, Saponification test, Sudan test – (Any 3 tests).

(Testing of a mixture with 3 unknown samples to be a major experiment for practical examination)

2. Effect of temperature / pH on salivary amylase activity

Plant Physiology

1. Determination of osmotic pressure of plant cell sap by plasmolytic method.
2. Compare the stomatal indices of hydrophytes, xerophytes and mesophytes.
3. Measurement of photosynthesis by Willmott's bubbler/any suitable method.
4. Estimation of plant pigments by colorimeter.
5. Measurement of Photosynthesis - Hill Reaction.

Animal Physiology

1. Study of tonicity of blood cells
2. Estimation of haemoglobin of blood using Haemoglobinometer
3. Total RBC count using Haemocytometer
4. Total WBC count using Haemocytometer
5. Estimation of microhaematocrit
6. Effect of adrenalin on heart beat of Cockroach (Demonstration)

Laboratory Record based on practicals

References

1. *Biochemical Methods. S. Sadasivam and A Manickam. New Age International Publishers*
2. *Hawks Physiological Chemistry, Bernard L. Oser (ed) TATA McGRAW Hill Publishing Company LTD, New Delhi, p 10- 15.*
3. *Physical Biochemistry by David Freifelder Publisher: W.H.Freeman &Co Ltd (September 1976)*
4. *A text book of practical physiology: CL Ghai: Jaypee brothers Medical Publishers (P) LTD, 2013*
5. *Dayananda, B. (1999). Experiments in Plant Physiology, Narosa Publishing House, New Delhi.*

IMSC506LS Biophysical Techniques & Biostatistics-Lab

Credits 2(0-0-6)

1. Working of various types of microscopes - Dark field microscope, Phase contrast microscope, Polarizing microscope, Fluorescent microscope
2. Micrometry - Measurement of microscopic objects.
3. Drawings using camera lucida
4. Chromatography – Determination of Rf value and identification of amino acid usingpaper chromatography
5. Separation of plant pigments by Thin Layer Chromatography (TLC)
6. Centrifugation- cell fractionation and separation of nuclei.
7. Preparation of standard curve and estimation of solute concentration in a sample using a colourimeter / spectrophotometer
8. Searching and data collection of online databases and online libraries.
9. Simple statistical problems - mean, median, mode, mean deviation & standard deviation for grouped and ungrouped data.
10. Construction of Line graph, Bar diagram, Pie diagram, Histogram, &Frequency Polygon
11. Introduction to a statistical software

Laboratory Record

References

1. An Introduction to Practical Biochemistry. David T Plummer
2. Biochemical Methods. S. Sadasivam and A Manickam. New Age International Publishers
3. Alonso, A., and Arrondo, J.L.R.2006. Advanced Techniques in Biophysics.Springer,UK
4. Clough, P. and C.Nutbrown.2002. A Student's Guide to Methodology: Justifying Enquiry. Sage, London.
5. Rajathi A. and P. Chandran, 2010. SPSS for You. MJP Publishers, Chennai

IMSC601LS Genetics

Credits 3(3-1-0)

Module I: Mendelian Genetics

Mendel's experiments- Monohybrid Cross, Dihybrid Cross, Test Cross, Back Cross and Reciprocal Cross. Principles of Inheritance. Chromosome Theory of Inheritance; Interaction of genes: Allelic: Incomplete Dominance (Four O Clock Plant), CoDominance (Skin colour in Cattle) Lethal Alleles (Yellow Fur colour in Mice); Non Allelic: Complementary (Flower colour in Sweet Pea), Supplementary (Coat colour in mice), Epistasis - dominant (Plumage in poultry) and recessive (Coat colour in mice), Polygenes (Skin colour inheritance in man), Pleiotropism (Drosophila), Multiple alleles – ABO Blood group system, Rh group and its inheritance, Extra nuclear inheritance: General characteristics, organelle DNA (mitochondrial and plastid DNA), Inheritance of Kappa particles in Paramecium.

Module II: Recombination and Linkage

Linkage and recombination of genes based on Morgan's work on Drosophila, Linked genes, Linkage groups, Chromosome theory of Linkage, Types of linkage- complete and incomplete, Two point & Three point cross, Factors affecting Crossing over and its significance, Interference & Coincidence, Linkage and Chromosome mapping (brief account only). Sex determination: Chromosome theory of sex determination (Autosome and Sex chromosomes), male heterogamy and female heterogamy, (xx-xo,xx-xy, zz), Genic Balance theory of Bridges. Barr bodies, Lyon's hypothesis, evidence for sex chromosome inactivation. Gynandromorphism, sex mosaics, intersex (Drosophila), Hormonal and Environmental influence on Sex determination (Bonelia).

Sex Linkage: Characteristics of Sex Linked inheritance, Sex Linked inheritance of man (Colour blindness and Hemophilia), Incompletely Sex Linked genes (Bobbed bristles in Drosophila), Pseudo autosomal genes, Holandric genes, Sex limited genes (Beard in man) and Sex influenced genes (inheritance of baldness in man).

Module III: Mutation

Types of mutations - Somatic, germinal, spontaneous, induced, autosomal and allosomal, chromosomal mutations, structural and numerical changes. Gene mutations, molecular basis of mutations, induced mutations, physical and chemical mutagens, factors causing mutation.

Module IV: Bacterial genetics

Bacterial Genome, Recombination in Bacteria- Transformation. Transduction,Conjugation, F mediated sexduction. Resistance Transfer Factor (RTF), Mechanism of drug resistance in Bacteria. Transposable genetic elements in Bacteria, Basic components and transposition in Bacteria.

Module V: Human Genetics

Karyotyping - Characterisation of chromosomes using various banding techniques such as Q banding, G banding, R banding, C banding and N banding. Normal Humanchromosome Complement, Pedigree analysis, Aneuploidy and Non- disjunction.

Autosomal abnormalities (Trisomy 21, Trisomy 18, Trisomy 13) Sex chromosomal abnormalities (Klinefelters syndrome, Turner's and Cri du chat syndrome) Single gene disorder (Brief mention) Autosomal single gene disorder (Achondroplasia, Huntington's Disease, Brachydactly), Inborn errors of metabolism such as phenylketonuria, alkaptonuria, sicke cell anaemia, Albinism. Multifactorial traits – polygenic disorder- cleft lip and cleft palate. Sex-linked Diseases – Colour blindness, Haemophilia, Holandric traits.

References

1. *Sinnut Dunn & Dobzhansky 1959, Principles of Genetics (T.M.H. New Delhi)*
2. *Sobti & Sharma 2008. Essentials of Modern Biology Ane's Student Edition*
3. *Stern C. 1973. Principles of Human Genetics (W.H. Freeman and Co.)*
4. *Strickberger W.M. 1990. Genetics (Mac Millan Publishing Co.)*
5. *Verma P.S and Agarwal V.K. 1998 Genetics (S. Chand and Co. New Delhi)*
6. *Vijayakumaran Nair 2006, Genetics &Molecular Biology. ContinentalPubl.,Trivandrum.*
7. *Whittinghill M. 1965 Human Genetics (Oxford & IBH Publ. Co.)*
8. *Winchester A.M. 1966. Genetics (Oxford & IBH Publications.*
9. *Zoological Society of Kerala Study material 2002. Cell Biology Genetics andBiotechnology.*

IMSC602LS Biotechnology

Credits 3(3-1-0)

Module I:Tools and Techniques in Biotechnology

Genetic engineering and recombinant DNA technology - Brief History, Scope and Importance, Enzymes in biotechnology (restriction endonucleases, ligases, modifying enzymes), Vectors- Plasmids, Phage vectors, Cosmids, Phagemids, Phasmids, Artificial Chromosomes, Probes, Linkers, Host cells. Basic steps & techniques in rDNA technology- Gene Libraries, Construction of genomic library and cDNA Library, PCR technique and DNA amplification, Brief description of screening methods – Nucleic Acid hydridization, In situ Hybridization, Fluorescence in situ Hybridization (FISH), Colony hybridization. Methods of transfer of desired gene into target cell. Blotting Techniques- Southern, Northern, Western, Dot Blotting. DNA Finger printing (DNA Profiling) and its application. Molecular Markers-RFLP

Module II:Animal Cell Culture

Brief account on methods, substrates, media and procedure of animal cell culture, Stem Cell Technology, types of stem cells and potential use, Organismal Cloning reproductive & therapeutic- brief account only.

Module III:Plant Tissue Culture

Basic components in tissue culture medium – Solid and liquid medium – suspension culture. Murashige and Skoog medium – composition and preparation. Aseptic techniques in tissue culture – sterilization – different methods – sterilization ofinstruments and glass wares, medium, explants; working principle of laminar air flow and autoclave; preparation of explants – surface sterilization. Inoculation,incubation, subculturing, Micropropagation - Different methods – axillary bud proliferation, direct and indirect organogenesis and somatic embryogenesis. Different phases of micropropagation – hardening, transplantation and field evaluation Advantages and disadvantages of micropropogation. Somaclonal variation.

References

1. *Bala Subramanian D., C.F & Bryle & K. Dharmajan J. Green Kunthala Jayaraman 2007. Concept in Biotechnology. University Press.*
2. *Benjamin Lewin 2004. Gene VIII Oxford University Press.*
3. *Bhojwnis abd Razdan Mk 2000. Plant Tissue Culture – Theory and practice Elsevier India Pvt. Ltd.*

4. *Brown C.H., Campbell I & Priest F, G. 1987. Introduction of Biotechnology (Blackwell scientific Oxford).*
5. *Colin Ratledge Bijorn Kristiansesn, 2008. Basic Biotechnology 3 rd ed. CambridgeUniversity.*
6. *De Robertis E.D. and De. Robertis E.M. 1987. Cell & Molecular Biology (Lea & Febya/Info-Med).*
7. *Dixon R.A, 2003. Plant Cell Culture, IRC Press Gardner E.J.& Sunstand D.P 1984. Principles of Genetics (John Wiley & Sons) New York.*
8. *John E. Smith 2005. Biotechnology Cambridge Low priced ed. (Third Ed) Madingan, John Rings 2009. Fundamental Genetics Cambridge University Press, Chapter 29.*
9. *Razdan M.K. 2000. An introduction to Plant Tissue Culture, Oxford IBH Publications, New Delhi.*
10. *Singh B.D Biotechnology 2002, Kalyan Publishers New Delhi.*

IMSC603LS Biosafety, Bioethics and IPR Issues

Credits 3(3-1-0)

Module I:Biosafety Guidelines and Regulations

Introduction and Development of Biosafety Practices, Definitions and Biosafety levels: 1,2,3,4., General lab requirements, Good Laboratory Practice (GLP) and Good Manufacturing Practice (GMP). Biological safety cabinets: centrifuges, Shipment of biological specimens, Biological waste management, Decontamination, Biosafety manuals, Medical surveillance, Emergency response, Biosafety protocol 2000. Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions (Indian context). Role of Public and Non-Governmental Organizations (NGOs).

Module II:Bioethics – Principles and Practice

What is Bioethics. History and Introduction. Ethical conflicts in biotechnology - interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics. Legal and Socio-economic Impacts of Biotechnology.

Ethical Issues in Genetically Modified Organisms: Foods and Crops. Use of Genetically Modified Organisms and their Release in the Environment, their Handling and Disposal. General guidelines for recombinant DNA research activity. Prenatal Diagnosis, Molecular Detection of Pre-Symptomatic Genetic Diseases and ethical issues. Stem Cell Research and ethical issues involved in Stem Cell research and use.

Animal Cloning, Human Cloning and their Ethical Aspects. Organ Transplantation and Ethical Issues. Bioethics in Biodiversity and Resource Management. Ethical, Legal and Social Implications of Human Genome Project. Genetics Studies on Ethnic Races.

Module III:Bioethics in Research

Use of Animals in Research and Testing, and Alternatives for Animals in Research.

Animal rights and animal laws in India. Prevention of cruelty to animals Act 1960 Wildlife protection act 1972 and Amendments, Biodiversity Act 2003. Animal protection initiatives - Animal Welfare, Animal Welfare Board, India CPCSEA,Working with Humans, harm, risk, and benefits, Consent. Testing of Drugs on Human Volunteers. Children and Vulnerable people, Equality, Anonymity, Confidentiality. Right to information- 2005.

Module IV:Intellectual Property Rights

Introduction to Intellectual Property Rights, Types of IP: Patents, Trademarks, Copyrights. Basics of Patents, Types of patents; Indian Patent Act 1970; Recent Amendments. Process Involved in Patenting. Patenting of Living Organisms, Traditional Knowledge, their commercial exploitation and protection. Introduction to the History of GATT, WTO, WIPO and TRIPS. Intellectual Property Rights and Agricultural Technology, and their Implications for India and other DevelopingCountries. International Organizations and Intellectual Property Rights.

References

1. *Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection. Oxford and IBH Publishing Co. New Delhi*
2. *Encyclopedia of Bioethics 5 vol set, 2003. ISBN - 10: 0028657748*
3. *Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press*
4. *Ganguli. 2001. Intellectual property rights –Tata McGrawhill. ISBN - 10:0074638602*
5. *Goel D. and Parasar S. 2013. IPR, Bioethics and Biosafty, Pearson Publications*
6. *Marie, M. 2005. Animal Bioethics: Principles and Teaching Methods. Wageningen Academic Publishers*
7. *Wattal.1997. Intellectual Property Right. Oxford Publicatiopn House ISBN:0195905024*

IMSC604LS Genetics Lab

Credits 2(0-0-6)

1. Study of normal male and female human karyotype (use photographs or Xerox copies) and abnormal human karyotypes - Down's Syndrome, Klinefeller'sSyndrome,Turner's Syndrome & Edward's Syndrome.
2. Genetics Problems - Di hybrid cross, test cross and sex linked inheritance
3. Bacterial transformation- competent cell preparation, plasmid selction, transformation, selection of transformants
4.Laboratory Record

References

1. Harper, P. S. 2003. Practical Genetic Counseling, 5th ed. Oxford:Butterworth Heineman.
2. Taneri, B., Asilmaz, E., Delikurt, T., Savas, P., Targen, S. and Esemen, Y., 2020. *Human Genetics and Genomics: A Practical Guide*. John Wiley & Sons.
3. VENNISON, S., 2009. *Laboratory manual for genetic engineering*. PHI Learning Pvt. Ltd

IMSC605LS Biotechnology Lab

Credits 2(0-0-6)

1. Preparation of nutrient medium for plant tissue culture – Murashige and Skoog medium, sterilization, preparation of explants, inoculation.
2. Immobilization of whole cells or tissues in sodium alginate.
3. Determination of appropriate flower bud containing uninucleate pollen for another culture using cytological techniques
4. Isolation of plant genomic DNA and quantification
5. Primer designing
6. PCR and analysis of PCR product by agarose gel electrophoresis
7. Restriction enzyme digestion of genomic DNA and analysis of restriction products
8. Laboratory Record

References

1. *Plant tissue culture: Theory and Practice - S.S Bhojwani and M.K. Razdan. Elsevier*
2. *Plant, Cell, Tissue and Organ Culture Fundamental Methods - Gamborg and Phillips, Narosa Publishers.*
3. *Molecular cloning : A laboratory Manual, Sambrook and Russel, Cold spring Harbor Lab Pub*
4. *Experiments in Microbiology, Plant Pathology and Biotechnology. K R Aneja. New Age International*
5. *PCR Applications protocols for functional genomics 1sted, By Michael A Innis , David H Gelfand& John J Sninsky,Published by Academic press*

Biology Major (Elective courses)

IMSE408LS-1 Molecules of Living Systems

Credits 2(2-1-0)

Module I: Introduction

Atoms, molecules and chemical bonds. Water: biological importance, pH and acid - basebalance. Buffers - biological importance.

Module II: Carbohydrates

Monosaccharides: Classification and nomenclature, Isomerism – structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars. Disaccharides: Sucrose, Lactose, Maltose, Isomaltose, Cellobiose and Trehalose. Polysaccharides: Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrans, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and Mucoproteins. Biological importance of carbohydrates.

Module III: Proteins

Structure, classification and properties of amino acids. Peptide bond formation and peptides. Colour reactions of amino acids and proteins.Protein structure: Primary structure of protein (e.g. insulin). Secondary structure -Conformation of proteins- chemical bonds involved, Alpha helix, Collagen helix,

Beta pleated sheet, Ramachandran angles and Ramachandran map. Tertiary structure- e.g. Myoglobin. Quaternary structure – e.g. Haemoglobin. Chaperons and folding of polypeptides.
Classification of proteins: a) based on structure (simple, conjugated, derived) b) based on molecular organisation and solubility (fibrous and globular proteins). Fibrous proteins- examples (Keratin, Collagen, Elastin, Resilin, Fibrous muscle proteins).Globular proteins – examples (albumin, globulin, myoglobin,lysozyme). Biological importance of proteins

Module IV: Lipids
Classification of lipids: simple, compound and derived lipids. Fatty acids: classification, nomenclature. Simple fats: Triacylglycerol (Triglycerides) - Physical properties. Reactions-Hydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids. Waxes, Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmologens, Glycolipids, Sphingolipids. Prostaglandins- structure, types and functions. Derived Lipids: Steroids: Structure, Biologically important steroids- cholesterol (types), Bile acids, Ergosterol, Terpenes, Lipoproteins. Biological importance of lipids.

Module V: Nucleic Acids
Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson –Crick model) Characteristic features of A, B, C and Z DNA. Structural organization of tRNA,rRNA and mRNA; Protein-nucleic acid interaction. DNA regulatory proteins, folding motifs,conformation flexibilities, denaturation, renaturation,DNA polymerases, Restriction endonucleases. Biological roles of nucleotides and nucleic acids.

Module VI: Enzymes
Chemical nature of enzymes, Specificity, Classification and nomenclature, mechanism of enzyme action, factors influencing enzyme action (temperature, pH, enzyme concentration, substrate concentration), enzyme activation, enzyme inhibition, allosteric enzymes, isoenzymes, co-enzymes.

Module VII: Vitamins and Minerals
Fat-soluble and water-soluble vitamins, Minerals important in living system, Biological significance of vitamins and minerals.

Module VIII: Hormones
Classification and types of hormones, Chemical nature of important hormones, Role of main hormones.

References

1. *Elliott,W.H. and C. Elliott. 2003. Biochemistry and Molecular Biology. Oxford University Press, Oxford, U.K.*
2. *Hanes, B. D. & N.M. Hoopar. 1998. Instant notes: Biochemistry. University of Leeds UK.*
3. *Lenhninger, A.L. 2008. Principles of Biochemistry. (5th edn). CBS Publishers & Distributors,Delhi.*
4. *Murray, K., Granner, D.K., et.al 2006. Harper's Biochemistry (25th edn). McGraw Hill, New York, USA.*
5. *Rama Rao, A.V.S.S. 1986. Text Book of Biochemistry. L.K. & S Publishers, New Delhi.*
6. *Voet, D. and J.G. Voet.2004. Biochemistry. John Wiley & Sons.,NY.*

IMSE408LS-2 Plant Physiology

Credits 2(2-1-0)

Module I: Water Relations
Physical aspects of absorption - Diffusion, imbibition, osmosis, OP, DPD, TP, WP, Concept of Water potential, matrix potential, pressure potential. Absorption of water active & passive, Ascent of sap - cohesion adhesion theory, Transpiration – types mechanism – theories - (starch - sugar, proton - K+ion exchange) – significance, leaf anatomy for regulating transpiration Control of stomatal mechanism , antitranspirants, Guttation.

Module II:Mineral Nutrition and Mechanism of Absorbtion
Essential and non essential elements- macro& micro- role- deficiency symptoms. Absorption of minerals– active & passive-ion exchange, carrier concept. Entry of minerals into roots.

Module III: Nitrogen Metabolism
N - cycle . N fixation processes. Biological N fixation – structure of nitrogenise complex, reduction of N, Symbiotic N fixation – nodule formation, leghaemoglobin, Nitrate and ammonium assimilation. Transport of amides and ureides.

Module IV:Photosynthesis
Photosynthetic pigments, photo exitation- Fluorescence, Phosphorescence -Absorbtion and action spectra, Red drop and Emerson enhancement effect, Concept of photo systems, Cyclic & Non Cyclic photophosphorylation, Carbon assimilation pathways-C3, C4, CAM- Photorespiration –factors affecting photosynthesis.

Module V:Translocation of Solutes
Pathway-phloem transport-mechanism-pressure flow-phloem loading and unloading.

Module VI:Respiration
Aerobic and Anaerobic, Glycolysis, Krebs cycle, Electron transport system & Oxidative phosphorylations, ATPases - chemi osmotic hypothesis-RQ –significance factors affecting respiration, β oxidation.

Module VII: Plant Responses to Environment
Allelochemicals-herbivory, Abiotic-concept of plant responses to water, salt&temperature stresses-Biotic factors (pathogens & insects), Mechanisms of resistance to biotic stress and tolerance to abiotic stress.

Module VIII:Sensory Photobiology
Structure, function and mechanisms of action of phytochromes, cryptochromes,phytochrome mediated plant responses, Photoperiodism and biological clocks – circadian rhythms, Floral induction and development

Module IX:Physiology of Growth and Development
Physiological effects and practical application of hormones-Auxins, Gibberillins,Cytokinins, ABA, ethylene. Physiology of flowering – phytochrome – photoperiodism– vernalisation. Biosynthesis, storage, breakdown, transport, physiological effects, and mechanism of action of plant growth hormones.

References

1. *Datta, S.C.1989. Plant Physiology, Central Book Depot, Allahabad.*
2. *Hopkins, W.G. 1999. Introduction to Plant Physiology. John Wiley and sons, New York.*
3. *Jain,V. K. 1996. Fundamentals of Plant Physiology, S Chand and Company, Delhi*
4. *Kochar, P.L. 1964. A Text Book of Plant Physiology, Atmaram & Sons, Delhi.*
5. *Malik, P.C. 1680. Plant Physiology, Kalyani Publishers, New Delhi.*
6. *Pandey, S. N. and Sinha, B. K.1986. Plant Physiology. Vikas Publishing house Pvt.Ltd.*
7. *Salisbury, F.B. & Ross, C.W. 1985. Plant Physiology, CBS Publishers and Distributers, Delhi.*
8. *Taiz, L. & Zeiger, E. 2003. Plant Physiology (3rd Edn). Panima Publishing Corporation, N.Delhi.*

IMSE408LS-3 Green chemistry

Credits 2(2-1-0)

ModuleI: Introduction to Green Chemistry
What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Module II: Principles of Green Chemistry and Designing a Chemical synthesis
Twelve principles of Green Chemistry with their explanations and examples and specialemphasis on the following:

Module III:Designing a Green Synthesis
Using these principles; Prevention of Waste/ byproducts;maximum incorporation of the materials used in the process into the final products ,Atom Economy, alculation of atom economy of the rearrangement, addition,substitution and elimination reactions.
Prevention/ minimization of hazardous/ toxic products reducing toxicity.
risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

Module IV:Green solvents– supercritical fluids, water as a solvent for organic reactions, ionicliquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solventsand how to compare greenness of solvents.

Module V:Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy. Selection of starting materials; avoidance of unnecessary derivatization – careful use

of blocking/protecting groups. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.
Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Module VI: Examples of Green Synthesis
1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction

ModuleVII:Future Trends in Green Chemistry
Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

References:

1. *Ahluwalia, V.K. &Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005).*
2. *Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998).*
3. *Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).*
4. *Cann, M.C. &Connely, M.E. Real-World cases in Green Chemistry, ACS, Washington (2000).*
5. *Ryan, M.A. &Tinnesand, M. Introduction to Green Chemistry, ACS, Washington (2002).*
6. *Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition,2010.*

IMSE507LS-1 Plant Cell Culture

Credits 2(2-1-0)

Module I:
Aseptic culture, Embryogenesis, organogenesis and plant regeneration, Clonal multiplication: meristem, shoot-tip maintenance and manipulation of development in embryogenic suspension cultures

Module II:
In vitro pollination and fertilization, Embryo culture, Endosperm culture, Triploid production, Haploid production - androgenic, gynogenic, uses of haploids, Suspension culture, Cellular totipotency, Somatic embryogenesis: Synthetic seeds,Haploid production, Anther and Pollen culture, Triploid production

Module III:
Protoplast isolation and culture, Somatic hybridization: fatty protoplasts, fusogens, mechanisms of protoplast fusion.

Module IV:
Selection of somatic hybrids, cytoplasmic hybridization (cybridization), genetic and breeding applications Manipulation with cells and protoplast in culture: Somaclonal variation, induction and selection of mutants, disease- and herbicide-resistant mutants, stress-tolerant mutants

Module V :
Genetic transformation of plants, direct DNA uptake, liposome-mediated DNA delivery, Agrobacterium mediated transformation, Tiplasmids, particle gun-mediated transformation, Production of Secondary plant products, Cryopreservation

References

1. *Chawla H.S. (2004)Biotechnology in crop improvement. International book Distribution Co.*
2. *Chrispeels M.J & Sadava D.E. (2002). Plants, genes and agriculture.The American Scientific publishers.*
3. *Donal Grierson & Convey S.V. (1984). Plant Molecular Biology. Blackie & Son Ltd, Newyork.*

4. *Ignacimuthu S. (1998).Plant biotechnology. Oxford & IBH Pub.*
5. *Moncia, A. Hughes. (1999). Plant Molecular genetics. Pearson education limited,England.*
6. *Purohit, Kothari and Mathur. (1993). Basic Agricultural Biotechnology. Agrobotanical Pub,*
7. *Razdan M.K. (2003). Introduction to plant tissue culture. Oxford. IBHpublishing Co.Pvt. Ltd*

IMSE507LS-2 Animal Cell Culture

Credits 2(2-1-0)

Module I: Introduction

History of animal cell culture, Laboratory requirements for animal cell culture, Sterilization techniques. Types of cell culture (Primary and Secondary), In vitro cultures—primary, diploid and established cell lines, Characterization and growth of the cultured cells, Stem cells, stem cell culture and their applications. Organ culture.

Module II: Media for Cell culture

Cell culture Media –Physical properties, balance salt solutions, complete media, Role of serum and supplements. Serum and protein free media and their application. Chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide

Module III:Techniques of Cell culture

Basic techniques of mammalian cell culture in vitro. Gene transfer methods in Animals – Microinjection, Embryonic Stem cell gene transfer, Retrovirus & Gene transfer. Transgenic Animals, Animal propagation – Artificial insemination, Animal Clones, Embryo transfer techniques. Culture of Specialized cells: Epithelia; Mesenchymal and connective tissues; Muscles; Neuroectoderm; Endocrine; Hematopoietic cells; Tumor cells. Cell cloning and cell separation; Cell differentiation; Cell synchronization and transformation; Measurement of cell death and apoptosis.

Module IV: Cell culture – Applications

Cryopreservation of cell cultures, application of animal cell cultures in production of therapeutics proteins. Hybridoma technology. Cell characterization—karyotyping, growth rates. Large scale production—suspension cultures, microcarriers, hollow fiber reactors.

References

1. *Basega, R. (ed): Cell Growth and Division: A Practical Approach. IRL Press.*
2. *Butler, M and Dawson, M. (eds.). Cell Culture Lab Fax, Eds., Bios Scientific Publications Ltd., Oxford.*
3. *Clynes, M. (ed).: Animal Cell Culture Techniques. Springer.*
4. *Freshney R. I., 2000. Culture of Animal cell: A manual of Basic Techniques (4th ed.), Wiley-Liss.*
5. *Masters, J. R. W. (ed): Animal Cell Culture – Practical Approach, Oxford Univ. Press.*
6. *Mather, J.P and Barnes, D. (eds). : Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Academic Press.*

IMSE606LS-1 Virology

Credits 2(2-1-0)

Module I: Basic Virology

History and principles of virology, virus taxonomy, introduction to replication strategies, Virus structure and morphology, viruses of veterinary importance and plant viruses.

Module II: Virological methods

Cultivation and purification of viruses In vivo and in vitro systems for virus growth, estimation of yields, methods for purification of viruses with special emphasis on ultracentrifugation methods

Module III: Virus - Diagnostic methods

Immunological - Immnuodiagnosis, haemagglutination and haemagglutination inhibition tests, imuno histochemistry. Nucleic acid based diagnosis - Nucleic acid hybridization, polymerase chain reaction, microarray and nucleotide sequencing.

Microscopic techniques - Fluorescence, confocal and electron microscopic techniques principles and applications.

Analytical techniques - Electrophoresis, chromatography, membrane filtration, NMR, Xray crystallography.

Module IV: Virus Replication

RNA viruses - General strategies, replication of plus stranded RNA virus (polio), negative strand RNA viruses (VSV and influenza). Replication of double stranded RNA virus (rota), ambisense RNA (LCM) and retroviruses (HIV and HTLV). DNA viruses - Replication of double stranded DNA viruses (SV40, pox), ssDNA virus (AAV), Prion proteins, replication of plant virus (Poty).

Module V: Viral Vaccines and Antivirals

Viral Vaccines - Conventional vaccines killed and attenuated, modern vaccines-recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines), vaccine delivery and adjuvants, large scale manufacturing—QA/QC issues. Antivirals - Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals —mechanism of action and drug resistance. Antisense RNA, siRNA, ribozyme

References:

1. *Alan Cann J. Cann. 2005. Principles of Molecular Virology. Elsevier Science & Technology Books.*
2. *Alan J. Cann. 2000. DNA Virus Replication. Oxford University Press.*
3. *B.N. Fields, D.M. Knipe, P.M. Howley, R.M. Chanock, J.L. Melnick, T.P. Monath, B.*
4. *Roizman, and S.E. Straus. Fields Virology Vol 1 and 2. eds.), 3rd Edition.LippincottRaven, Philadelphia, PA.*
5. *Flint S. J., Racaniello V. R., Enquist L. W. Rancaniello V. R. & A. M. Skalka. 2003.*
6. *Principles of Virology: Molecular Biology, Pathogenesis, and Control of AnimalViruses. AmericanSociety Microbiology.*
7. *John R. Stephenson (Editor), Alan Warnes 1998 . Diagnostic Virology Protocols: Methods in Molecular Medicine. Humana Press.*
8. *Paul F. Torrence (Editor). 2005. Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Wiley, John & Sons, Incorporated.*
9. *Pierre Payment, Trudel (Editor). 1993. Methods and Techniques in Virology. Publ.Marcel Dekker*
10. *Wolfram H. Gerlich (Editor), Detlev H. Krueger (Editor), Rainer Ulrich (Editor).1996. Chimeric Virus like Particles as Vaccines. Karger, S. Inc.*

IMSE606LS-2 Natural hazards& Introduction to Disaster Management

Credits 2(2-0-0)

Module 1: Introduction

Definition of hazard; natural, technological, and context hazards; concept of risk and vulnerability; reasons of vulnerability - rapid population growth, urban expansion, environmental pollution, epidemics, industrial accidents, Disaster Management cycle

Module2: Natural hazards

Natural hazards: hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter; volcanoes: causes of volcanism, geographic distribution; floods: types and nature, frequency of flooding; landslides: causes and types of landslides, landslide analysis; drought: types of drought - meteorological, agricultural, hydrological, and famine; Glacial Lake Outburst Floods (GLOF); tornadoes, cyclone & hurricanes; tsunamis: causes and location of tsunamis; coastal erosion, sea level changes and its impact on coastal areas and coastal zone management.

References

1. *Coppola D. P. 2007. Introduction to International Disaster Management. Butterworth Heinemann.*
2. *Cutter, S.L. 2012. Hazards Vulnerability and Environmental Justice. EarthScan, Routledge Press.*
3. *Keller, E. A. 1996. Introduction to Environmental Geology. Prentice Hall, Upper Saddle River, New Jersey.*
4. *Pine, J.C. 2009. Natural Hazards Analysis: Reducing the Impact of Disasters. CRC Press, Taylor and Francis Group.*
5. *Schneid, T.D. & Collins, L. 2001. Disaster Management and Preparedness. Lewis Publishers, New*

IMSE606LS-3 Nano Materials

Credits 2(2-1-0)

Module I: General Introduction to Nanomaterials

Emergence of nanotechnology,defining nanodimensional materials, size effects innanomaterials , Moore's law, , physical and chemical methods of synthesis of nanomaterials,synthesis and properties of fullerenes and carbon nanotubes,synthesis of nanoparticles of gold, silver, rhodium, palladium and platinum,techniques of synthesis-electroplating and electrophoretic deposition, conversionthrough chemical reactions and lithography. Thin films-chemical vapor depositionand atomic layer deposition techniques,

Module II: Diversity in Nanosystems

Nanofabricationmethods: top-down and bottom-up methods, self assembled monolayers on gold-growth processand phase transitions. Gas phase clusters- formation, detection and analysis.quantum concepts.Quantum dots- preparation, characterization and applications. Nanoshells-types ofsystems, characterization and application.

Module III: Interfaces of Nanotechnology

Nanobiology, nanosensors, nanomedicines.Types of nanostructured materials: nanocrystals, nanoparticles, oxide nanostructures, nanotubes and nanowires. Characterization of nanoparticles: transmission electron microscopy(TEM), atomic forcemicroscopy(AFM), X-ray spectroscopy.

Module IV: Shape of Nanoparticles

Exterior surface and particle shape, interior nanoscale surfacearea, specific surface area, spherical cluster approximation, packing fractions and density,structural magic numbers.Nanooptics: interaction of light with nanoparticles, surface Plasmon resonance, colourgeneration from nanoparticles, quantum dots,Determination of nanoparticle size, surface area and porosity-BET method, BJH method,Mercury Porosimeter method.

References

1. *H.S. Nalwa, R. Smalley, Encyclopedia of Nanoscience and Technology, American Scientific Pub., 2004.*
2. *C.N. R. Rao, A. Govindraj, Nanotubes and Nanowires, 2nd Edn., RSC, 2011.*
3. *C.N.R. Rao, A. Muller, A.K. Cheetham, The Chemistry of Nanomaterials, Vol 1-2, John Wiley & Sons, 2005.*
4. *G. Schmid, Nanoparticles: From Theory to Applications, John Wiley & Sons, 2011.*
5. *G.L. Hornyak , H.F. Tibbals , et.al. Introduction to Nanoscience & Nanotechnology, CRC Press, 2009.*

Computer Science Major (Core courses)

IMSC406CS Data Structures Using C-Lab

Credits 2(0-0-6)

Given the problem statement, students are required to formulate problem, develop algorithm, flowchart, code, execute and test it and analyse performance of the programs based on the theory of the course "Data Structures". Students should be given programming assignments on following :

- Operations on Linked Lists (Singly, Doubly, Circular), Operations on Stack and Queue using arrays and linked lists
- Trees and Graphs data structures and their operations, Programs for search and sorting algorithms.
- Implementing Red-Black and Splay Trees and Tries.

References

1. *Aaron M. Tenenbaum, YedidyahLangsam, Moshe J. Augenstein, Data Structures Using C, Pearson.*
2. *Kutti, Padhye, Data Structures in C++, PHI, First Edition..*
3. *Data structures and Algorithm Analysis in C, 2nd edition, M. A. Weiss, Pearson.*
4. *Robert Kruse & Clovis L. Tondo" Data Structures and Program Design in C", Prentice Hall.*

IMSC407CS Microprocessor Lab

Credits 2(0-0-6)

The students shall be trained to do program on microprocessor 8086 and above based on the theory course "Microprocessor and Assembly Language Programming" such as:

- Basic programming to implement arithmetic/conditional/loop and string operations, sub procedures and macros.
- Use of Interrupts for input and output through ports and devices (Keyboard & Mouse).
- Programming on 8254/8257/8259 programmable devices.

References

1. *Berry.B.Brey, The Intel Microprocessors 8086/8088 /80186/80188, 80286, 80386,80486 PENTIUM, PENTIUM Pro, PII, PIII & IV Architecture, Programming & Interfacing, Pearson Education , 8th Edition.*
2. *A. NagoorKani, 8086 Microprocessors and its Applications 2nd Edition.*
3. *Abel P., IBM PC Assembly Language and Programming, Fifth Edition, Pearson Education, Asia*.

IMSC501CS Object Oriented Programming with C++

Credits 3(3-1-0)

Module I:

Basics: Introduction to Object Oriented Programming and its Features, Characteristics of Object-Oriented Language, Basic Components of C++, Structure of a C++ Program, Flow Control Statements in C++, Functions - Scope of Variables, Inline Functions, Recursive Functions, Pointers to Functions, C++ Pointers, Arrays, Dynamic Memory Allocation and De-Allocation

Module II:

Differences Between Object Oriented and Procedure Oriented Programming, Abstraction, Overview of Object-Oriented Programming Principles, Encapsulation, C++ Classes, Objects, User Defined Types, Constructors and Destructors, this Pointer, Friend Functions, Data Abstraction, Operator Overloading, Type Conversion

Module III:

Class Inheritance, Base and Derived Classes, Virtual Base Class, Virtual Functions, Polymorphism, Static and Dynamic Bindings, Base and Derived Class Virtual Functions, Dynamic Binding through Virtual Functions, Pure Virtual Functions, Abstract Classes, Virtual Destructors

ModuleIV:

Stream Classes Hierarchy, Stream I/O, File Streams, Overloading the Extraction and Insertion Operators, Error Handling during File Operations, Formatted I/O

ModuleV: Exception Handling- Benefits of Exception Handling, Throwing an Exception, the Try Block, Catching an Exception, Exception Objects, Exception Specifications, Rethrowing an Exception, Uncaught Exceptions

References

1. *Problem solving with C++: The Object of Programming, Walter Savitch, 4th Edition, Pearson Education.*
2. *C++: The Complete Reference, Herbert Schildt, 4th Edition*
3. *Object Oriented Programming in C++, Lafore, 4th Edition, Pearson Education.*
4. *Object Oriented Programming with C++, SouravSahay, 2nd Edition, Oxford*
5. *The C++ Programming Language, B. Stroutstrup, 3rd Edition, Pearson Education*
6. *Programming in C++, Ashok N Kamthane. Pearson 2nd Edition*

IMSC502CS Data Communications and Networking

Credits 3(3-1-0)

Module I: Introduction to Computer Networks and Networking Elements

Network Definition, Network Topologies, Network Classifications, Network Protocol, Layered Network Architecture, Overview of OSI Reference Model, Overview of TCP/IP Protocol Suite, Hub, Switch (Managed and Unmanaged), Routers

ModuleII: Data Communication Fundamentals and Techniques

Analog and Digital Signal, Data-Rate Limits, Digital to Digital Line Encoding Schemes, Pulse Code Modulation, Parallel and Serial Transmission, Digital to Analog Modulation - Multiplexing Techniques-FDM, TDM, Transmission Media.

Module III: Networks Switching Techniques and Access Mechanisms

Circuit Switching, Packet Switching- Connectionless Datagram Switching, Connection- Oriented Virtual Circuit Switching; Dial-Up Modems, Digital Subscriber Line, Cable TV for Data Transfer.

Data Link Layer Functions and Protocol: Error Detection and Error Correction Techniques, Data-Link Control- Framing and Flow Control, Error Recovery

Protocols-Stop and Wait ARQ, Go-Back-N ARQ, Point to Point Protocol on Internet.

Module IV: Multiple Access Protocol and Network Layer

CSMA/CD Protocols, Ethernet LANS; Connecting LAN and Back -Bone Networks- Repeaters, Hubs, Switches, Bridges, Router and Gateways, Networks Layer Functions and Protocols, Routing, Routing Algorithms, Network Layer Protocol of Internet - IP Protocol, Internet Control Protocols.

ModuleV: Transport Layer and Application Layer Functions and Protocols

Transport Services- Error and Flow Control, Connection Establishment and Release- Three Way Handshake, Overview of Application Layer Protocol, Overview of DNS Protocol; Overview of WWW & HTTP Protocol.

References

1. *B. A. Forouzan: Data Communications and Networking, 5th edition, TMH Publishing Company Ltd .*
2. *A. S. Tanenbaum: Computer Networks, 4th edition, PHI Pvt. Ltd.*
3. *William Stallings- Data and Computer communications, 8th edition, Pearson.*
4. *WillaimL.Sechwebar- Data Communications, 1st edition, Tata McGraw Hill Publishing Co Ltd .*

IMSC503CS Design and Analysis of Algorithms

Credits 3(3-1-0)

Module I: Introduction

The Role of Algorithms in Computing, Algorithm Design Techniques,Performance Analysis.

Module II: Divide and Conquer

The General Method, Binary Search, Finding the Maximum and Minimum, Performance Measurement of: Quick Sort and Merge Sort, Stassen's Matrix Multiplication, Convex Hull.

Module III: Greedy Algorithm

General Characteristics, Problem Solving using Greedy Algorithm, Minimum Cost Spanning Trees.

Dynamic programming: The General Method, Multistage Graphs, All-Pairs Shortest Paths, Single Source Shortest Path, Traveling Sales Person Problem.

Module IV: Basic Traversal and Search Techniques

Techniques for Binary Trees, Techniques for Graphs.Backtracking: General Method, The 8-Queens Problem, Graph Coloring, Hamiltonian Cycles.Branch and Bound: General Method, Problem Solving using Branch and Bound Techniques.

Module V: Lower Bound Theory
Introduction, Techniques for Deriving Good Lower Bounds.

References

1. *E. Horowitz, S. Sahni, SanguthevarRajeshekharan, Computer Algorithms/C++, 2nd Edn, Universities Press.*
2. *Basu S.K., Design Methods and Analysis of Algorithms, Second Edition, Prentice Hall.*
3. *Richard Neapolitan, KumarsNaimipour, Foundations of Algorithms, , Fourth Edition, Jones and Barlett Publishers, Canada.*
4. *Sara Base Allen Van Gelder, Computer Algorithms: Introduction to Design & Analysis, Pearson Edn. Asia.*
5. *P. Gupta, V. Agarwal, M. Varshney, Design and Analysis of Algorithms, Second Edition, Prentice Hall India.*

IMSC504CS Database Management Systems

Credits 3(3-1-0)

ModuleI:Basic Database Concepts
Terminology, and Architecture; Types of Database Management Systems. Differences between Relational and other Database Models. Data Modelling: Relations, Schemas, Constraints, Queries, and Updates; Conceptual vs. Physical Modeling; Entity Types, attributes, ER Diagrams.

Module II: SQL Data Definition
Specifying Tables, Data Types, Constraints; Simple SELECT, INSERT, UPDATE, DELETE Statements; Complex SELECT Queries, including Joins and Nested Queries; Actions and Triggers; Views; Altering Schemas.

Module III:Relational Algebra
Definition of Algebra; Relations as Sets; Operations: SELECT, PROJECT, JOIN, etc. Normalization Theory and Functional Dependencies, 2NF, 3NF, BCNF, 4NF, 5NF.

Module IV: Indexing
Files, Blocks, and Records, Hashing; RAID; Replication; Single-Level and Multi-Level Indexes; B-Trees and B+-Trees. Query Processing Translation of SQL into Query Plans; Basics of Transactions, Concurrency and Recovery.

ModuleV: Database Security and Authorization
Types of Security – Control measures – Database Security and DBA – Access Control , User Accounts, and Database Audits –Access Control based on Granting and Revoking Privileges.
Introduction to Database Programming.

References

1. *Fundamentals of Database Systems, ElmasriRamez, NavatheShamkant. 6th Edition, Addison-Wesley*
2. *Data base Management Systems, Raghu Ramakrishnan, Johannes Gehrke, 3rd Edition, McGraw Hill Education*
3. *Data base System Concepts, A. Silberschatz, H. F. Korth, S. Sudarshan, 7th Edition, McGraw Hill Education*
4. *An Introduction to Database Systems, C.J. Date, 8th edition, Pearson Education*

IMSC505CS Programming with C++ (Lab)

Credits 2(0-0-6)

Students are required to understand the object-oriented concepts using C++. They are required to practice the concepts learnt in the theory.

References

1. *Object Oriented Programming with C++, SouravSahay, 2nd Edition, Oxford*
2. *The C++ Programming Language, B. Stroutstrup, 3rd Edition, Pearson Education*

IMSC506CS DBMS Lab

Credits 2(0-0-6)

Students are required to practice the concepts learnt in the theory by designing and querying a database for a chosen organization (Like Library, Transport etc).

References*;*

1. *Fundamentals of Database Systems, ElmasriRamez, NavatheShamkant. 6th Edition, Addison-Wesley*
2. *Data base Management Systems, Raghu Ramakrishnan, Johannes Gehrke, 3rd Edition, McGraw Hill Education*
3. *Data base System Concepts, A. Silberschatz, H. F. Korth, S. Sudarshan, 7th Edition, McGraw Hill Education*
4. *An Introduction to Database Systems, C.J. Date, 8th edition, Pearson Education*

IMSC601CS Systems Programming

Credits 3(3-1-0)

Module I: Introduction to System Software

Program Development Environment, Language Processors, Kinds of Language Processors, Activities, Symbol Tables.

Module II: Assemblers

Assembly Language Programming, Macros and Macro Preprocessors, Design of a Two Pass Assembler.

ModuleIII: Linkers and Loaders

Relocation and Linking Concepts, Design of a Linker, Dynamic Linking, Loaders,
Scanning and Parsing: Programming Language Grammars, Top-Down and Bottom-up Parsing, Language Processor Development Tools, LEX and YACC.

Module IV: Compilers

Introduction, Data Structures used in Compilers, Memory Allocation, Compilation of Expressions, Control Structures, Code Optimization: Optimizing transformations, Local Optimization, Global OptimizationInterpreters.

Module V: Interpreters

Overview of Interpretation, Kinds of Interpreters, The Java Language Environment, Software Tools: Tools for Program Development, Editors, Debug Monitors, User Interfaces.

References

1. *D M Dhamdhere, Systems Programming and Operating Systems, Tata McGraw-Hill Education.*
2. *R. Anthony, Systems Programming: Designing and Developing Distributed Applications, Morgan Kaufmann.*
3. *I.A.Dhotre, A.A.Puntambekar, Systems Programming, Technical Publications, 3rd Revised Edn, Pune.*
4. *Donovan, J, Systems Programming, Tata McGraw-Hill Education.*

IMSC602CS Security in Computing

Credits 3(3-1-0)

Module I : Introduction

Security Goals, Threats, Attacks, Assets, Intruders, Malicious Software-Viruses, Worms, Bots, Rootkits etc.

Module II:Authentication and Program Security

Passwords, Access control Mechanisms, User Level-Program Level Protection, Intrusion Detection, Malware Defence, Antivirus Approaches, Dealing with Buffer Overflow attacks, Protection in Operating Systems such as UNIX, Trusted Operating Systems.

ModuleIII:Cryptography

Basic Encryption, Decryption, Classification of Ciphers, Symmetric Cryptosystems, Data Encryption Standard (DES), Advanced Encryption Standard (AES), Public Key Cryptography, Principles, Applications, Cryptographic Algorithms, RSA, Digital Signature.

ModuleIV:Network Security

Security Attacks, Security Services, Network Security Model, Electronic Mail Security, Firewalls, Secure Socket Layer, Trusted Network.

Module V:Security in Database

Database Confidentiality and Integrity, Dynamic Database Protection Schemes, Context Oriented Protection, Security with Distributed Systems.

References

1. *Charles P Pfleeger, Security in computing, Prentice Hall .*
2. *William Stallings, Cryptography and Network Security, Pearson, 6th Ed., 2014.*
3. *William Stallings, Network Security Essentials Applications and Standards, Pearson Education Asia.*
4. *M. Stamp, "Information Security: Principles and Practice, Wiley.*
5. *M. Bishop, "Computer Security: Art and Science," Addison Wesley.*
6. *William Stallings, Operating Systems: Internals and Design Principles, 7th Ed., Prentice-Hall.*

IMSC603CS Machine Learning

Credits 3(3-1-0)

Module I: Introduction

Concept of Machine Learning, Applications of Machine Learning, Key elements of Machine Learning, Supervised vs. Unsupervised Learning, Statistical Learning: Bayesian Method, The Naive Bayes Classifier

Module II: Linear Regression

Prediction using Linear Regression, Gradient Descent, Linear Regression with one Variable, Linear Regression with Multiple Variables, Polynomial Regression, Feature Scaling/Selection.

Module III: Logistic Regression

Classification using Logistic Regression, Logistic Regression vs. Linear Regression, Logistic Regression with one Variable and with Multiple Variables.

ModuleIV: Regularization

Regularization and its Utility: The problem of Overfitting, Application of Regularization in Linear and Logistic Regression, Regularization and Bias/Variance.

Module V: Neural Networks

Introduction, Model Representation, Gradient Descent vs. Perceptron Training, Stochastic Gradient Descent, Multilayer Perceptrons, Multiclass Representation, Back Propagation Algorithm.

References

1. *EthemAlpaydin, "Introduction to Machine Learning", 2nd and 4th Edition, The MIT Press.*
2. *Tom M. Mitchell, "Machine Learning", 1st Edition, Tata McGraw-Hill Education.*
3. *Christopher M. Bishop, "Pattern Recognition and Machine Learning".*
4. *Kevin P. Murphy, "Machine Learning, 2nd Edition, The MIT Press.*
5. *Yegnanarayana B, Artificial Neural Networks , Prentice-HallIndia Pvt.Ltd.*
6. *Mastering Machine Learning: A Step-by-Step Guide with MATLAB", MathWorks.*
7. *Giuseppe Ciaburro, "MATLAB for Machine Learning", Packt Publishing Limited.*
8. *U Dinesh Kumar, Manaranjan Pradhan, "Machine Learning using Python", Wiley.*
9. *S. Sivanandam, et.al. " Introduction to Neural Networks using Matlab 6.0, Tata McGraw-Hill Education.*

IMSC604CS Java Programmimg

Credits 2(0-0-6)

Students are required to implement the following object-oriented concepts using Java.
Classes and Objects, Methods, Constructors, Encapsulation, Abstraction, Abstract methods and classes, Interfaces, Visibility control, Inheritance, Polymorphisms, Java Packages, Multi Threaded Programming. Network programming using Java, String Handling, Java Utility classes, Database Handling using JDBC. Exception Handling, Wrapper Classes, Autoboxing, Applets, Event Handling, AWT.
Advanced Spring Framework :Spring boot and Spring data, MVC.

References

1. *Herbert Schildt, Java: A Beginner's Guide, Ninth Edition, Oracle, Mc-Graw Hill education, 2017.*
2. *Craig Walls, Spring in Action: Covers Spring 4, Manning publications, Fourth edition.*
3. *Mastering Java Machine Learning, Krishna Choppella and Uday Kammath, Packet Publishing, 2017.*
4. *Herbert Schildt, Java: The Complete Reference.*

IMSC605CS Machine Learning Lab (Matlab/Python)

Credits 2(0-0-3)

Students are required to practice the concepts learnt in the theory using Matlab/Python.

References

1. *EthemAlpaydin, "Introduction to Machine Learning", 2nd and 4th Edition, The MIT Press.*
2. *Tom M. Mitchell, "Machine Learning", 1st Edition, Tata McGraw-Hill Education.*
3. *Christopher M. Bishop, "Pattern Recognition and Machine Learning".*
4. *Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", The MIT Press.*

Computer Science Major (Elective courses)

IMSE408CS-1 Microprocessor and Assembly Language Programming

Credits 2(2-1-0)

ModuleI: Intel 8086 Microprocessor
Architecture, Pipelining, Execution of Instructions, Physical memory organization, Segmentation, Register organization, Introduction to Intel 80286 & 80386, Motorola series of microprocessors.

Module II: Microcomputer Architecture& signals
Intel 80386&80486, Pipelining and Execution of Instructions, Memory Subsystem, Paging Mechanism, Instruction Set, Comparison with Motorola series of microprocessors.

Module III:Assembly Language Programming
Fundamentals of Assembly Language, Assembly Language Programming Features, 8086 instructions, Addressing modes.

ModuleIV:Interrupts and Interrupt Service routines
Interrupt Cycle of 8086, Interrupts in Programming, Programming on 8254/8257/8259 programmable devices.

ModuleV:Keyboard and Mouse Operations
Defining and using Procedures and Macros. Linking to Subprograms.

References

4. *A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and Peripherals- Architectures, 3e, McGrawHill Education (India)Pvt. Ltd..*
5. *Berry.B.Brey, The Intel Microprocessors 8086/8088 /80186/80188, 80286, 80386,80486 PENTIUM, PENTIUM Pro, PII, PIII & IV Architecture, Programming & Interfacing, Pearson Education , 8th Edition.*
6. *A. NagoorKani, 8086 Microprocessors and its Applications 2nd Edition.*
7. *Dandamudi, S.P., Introduction to Assembly Language Programming, Springer.com.*
8. *Abel P., IBM PC Assembly Language and Programming, Fifth Edition, Pearson Education, Asia*.

IMSE408CS-2 Data Structures

Credits 2(2-1-0)

Module I: Basic concepts
Algorithm Specification, Recursive algorithms, Data Abstraction, Performance analysis, Linear and Non Linear data structures, Singly Linked Lists, Operations, Concatenating, circularly linked lists, Doubly Linked Lists, Representation of single, two dimensional arrays, sparse matrices-array and linked representations.

Module II:Stack
Operations, Array and Linked Implementations, Applications, Queue- Definition and Operations, Array and Linked Implementations, Circular Queues - Insertion and Deletion Operations, Dequeue (Double Ended Queue).

Module III:Trees
Representation of Trees, Binary tree, Array and Linked Representations, Binary Tree Traversals, Threaded Binary Trees, Heap- Definition, Insertion, Deletion.

Module IV:Graphs
Graph ADT, Graph Representations, Graph Traversals, Searching, Hashing- Introduction, Hash tables, Hash functions, Overflow Handling.

Module V:Sorting Methods Search Trees, AVL Trees.

References

5. *Aaron M. Tenenbaum, YedidyahLangsam, Moshe J. Augenstein, Data Structures Using C, Pearson.*
6. *Fundamentals of Data structures in C, 2nd Edn, E. Horowitz, S. Sahni and S, Anderson-Freed, Univ. Press.*
7. *DebashishSamanta, Classic Data Structures, PHI Second Edition.*
8. *Kutti, Padhye, Data Structures in C++, PHI, First Edition..*
9. *Data structures and Algorithm Analysis in C, 2nd edition, M. A. Weiss, Pearson.*
10. *Robert Kruse & Clovis L. Tondo" Data Structures and Program Design in C", Prentice Hall.*

IMSC408CS-3 Computer Architecture

Credits 2(2-1-0)

Module I:
Theory of Parallelism Parallel Computer Models, The State of Computing, Multiprocessors and Multicomputers, Multivector and SIMD Computers, PRAM and VLSI Models, Principles of Scalable Performance, Performance Metrics and Measures, Parallel Processing Applications, Scalability Analysis and Approaches.

Module II:
Processors and Memory Hierarchy, Advanced Processor Technology, Superscalar and Vector Processors, Memory Hierarchy Technology, Virtual Memory Technology, Bus, Cache and Shared Memory, Bus Systems, Cache Memory Organisations, Shared-Memory Organisations.

Module III:
Pipelining and Superscalar Techniques, Linear Pipeline Processors, Nonlinear Pipeline Processors, Instruction Pipeline Design, Arithmetic Pipeline Design, Superscalar Pipeline Design.

Module IV:
Multivector and SIMD Computers, Vector Processing Principles, Multivector Multiprocessors, Compound Vector Processing, SIMD Computer Organisations.

Module V:
Scalable, Multithreaded and Dataflow Architectures, Latency-Hiding Techniques, Principles of Multithreading, Fine-Grain Multicomputers, Scalable and Multithreaded Architectures, Introduction to Software for Parallel Programming.

References

1. *Kai Hwang and NareshJotwani , Advanced Computer Architecture, Tata Mc.Graw-Hill Education.*
2. *S.S.Jadhav, Advanced Computer Architecture and Computing, Technical Publications Pune.*
3. *Richard.Y.Kain, Advanced Computer Architecture ,A Systems Design Approach, Prentice-Hall India.*
4. *DezsoSima, Terence Fountain, Peter Kacsuk, Advanced Computer Architectures – A Design Space Approach, Addison-Wesley.*

IMSE507CS-1 Software Engineering

Credits 2(2-1-0)

Module I: Introduction to Software and Software Engineering
Software Development Process Models-The Serial or Sequential ; Iterative; The incremental.

ModuleII: Software Design Principles
Introduction, System Models, Data Dictionaries; Software Design Process, Design Strategies, Architectural Design, System Structuring, Domain-Specific Architectures.

Module III: Object Oriented Design
Introduction; An Object -Oriented Design Example, Object Aggregation; Object Interface Design, Function Oriented Design, Data–Flow Design; Structural Decomposition: Detailed Design – 3-Layer class diagram.

Module IV:Software Testing Strategies
White Box/ Black Box, Unit/Integrated, Software Testing Techniques, Testing Conventional Applications, Testing Object-Oriented Applications, Testing Web Applications.

Module V:Project Management Concepts
Process and Project Metrics, Estimation for Software Projects, Project Scheduling, Risk Management.

References

1. *Roger Pressman and Bruce, Software Engineering: A Practitioner's Approach 9th edition, MecGraw Hill ISE.*
2. *BhuvanUnhelkar, Software Engineering with UML, CRC Press.*
3. *Sommerville, I., Software Engineering Global Edition, Pearson Education..*
4. *Rajib Mall, Fundamentals of Software Engineering,4th Edition, PHI.*
5. *Pressman, R.S., Software Engineering: A Practitioner's Approach, MGHISE, 7th Edition.*
6. *AnirbanBasu, Software Quality Assurance, Testing and Metrics, First Edition, PHI.*

IMSE507CS-2 Compiler Construction

Credits 2(2-1-0)

ModuleI: Language Processors
The Structure of a Compiler, The Evolution of Programming Languages, The Science of Building a Compiler, Application of Compiler Technology, A Simple Syntax-Directed Translator.

ModuleII: Lexical Analysis
Specification and Recognition of Tokens, The Lexical Analyzer Generator: Lex, Finite Automata, From Regular Expressions to Automata, Design of a Lexical-Analyzer Generator, Optimization of DFA-Based Pattern Matchers.
Syntax Analysis: Context-Free Grammars, Top-Down and Bottom-Up Parsing. Introduction to LR Parsing: Simple LR, More Powerful LR Parsers, Using Ambiguous Grammars, Parser Generators.

ModuleIII: Syntax Directed Translation
Evaluation Orders for Syntax Directed Definitions, Applications of Syntax-Directed Translation, Syntax-Directed Translation.
Intermediate-Code Generation: Variants of Syntax Trees, Three-Address Code, Types and Declarations, Translation of Expressions, Type Checking, Control Flow, Backpatching, Switch-Statements, Intermediate Code for Procedures.

ModuleIV: Run-Time Environments
Storage Organization, Stack Allocation of Space, Access to Nonlocal Data on the Stack, Heap Management, Garbage Collection.

Module V: Code Generation
Issues in the Design of a Code Generator, A Simple Code Generator, Peephole Optimization, Register Allocation and Assignment, Optimal Code Generation for Expressions, Dynamic Programming Code-Generation.

References
1. A. V. Aho, M. S. Lam, R. Sethi, Jeffrey D. Ullman, Compilers Principles,Techniques &Tools, Pearson Education.
2. Anthony J. Dos Reis, Compiler Construction Using java, JavaCC and Yacc, John Wiley & Sons, Inc.
3. Charles N. Fischer, Ron K. Cyntron, Richard J, Le Blanc, Jr., Crafting A Compiler, Pearson Education.

IMSE606CS-1 Introduction to Artificial Intelligence

Credits 2(2-1-0)

ModuleI: Introduction to Artificial Intelligence
Definition of AI; Turing Test; Brief History of AI. Problem Solving and Search: Problem Formulation; Search Space; States vs. Nodes; Tree Search: Breadth-First, Uniform Cost, Depth-First, Depth-Limited, Iterative Deepening; Graph Search.

ModuleII: Informed Search
Greedy Search; A* Search; Heuristic Function; Admissibility and Consistency; Deriving Heuristics via Problem Relaxation. Local Search: Hill -Climbing; Simulated Annealing; Genetic Algorithms; Local Search in Continuous Spaces.

ModuleIII: Playing Games
Game Tree; Utility Function; Optimal Strategies; Minimax Algorithm; Alpha-Beta Pruning; Games with an Element of Chance. Beyond Classical Search: Searching with Nondeterministic Actions; Searching with Partial Observations; Online Search Agents; Dealing with Unknown Environments.

ModuleIV: Knowledge Representation and Reasoning
Ontologies, Foundations of Knowledge Representation and Reasoning, Representing and Reasoning about Objects, Relations, Events, Actions, Time, and Space; Reasoning about Knowledge, Propositional and Predicate logic, Situation Calculus, Description Logics, Reasoning with Defaults,
Sample Applications.

ModuleV: Representing and Reasoning with Uncertain Knowledge
Probability, Connection to Logic, Independence, Bayes Rule, Bayesian Networks, Probabilistic Inference, Applications.

References

1. *Artificial Intelligence, Elaine Rich, McGraw Hill.*
2. *Introduction to Artificial intelligence and expert systems by Dan W. Patterson, Prentice HallIndia.*
3. *Principles of Artificial Intelligence, Nilson. N.J, Springer Verlag.*
4. *Introduction to Artificial Intelligence, Charvanak E. and McDermoti D, Addison Wesley.*
5. *Artificial Intelligence and Intelligent Systems by N.P Pandhy. Oxford Publications.*
6. *Elaine Rich, Kevin Knight, Shivashankar B Nair, Artificial Intelligence, McGraw Hill Edition.*
7. *Artificial Intelligence: A Modern Approach, Russell Stuart Jonathan and Norvig Peter.*

IMSE606CS-2 Computer Graphics

Credits 2(2-1-0)

ModuleI: Introduction

Application Areas of Computer Graphics, Overview of Graphics Systems and Devices. Points and Lines, Line Drawing Algorithms, Mid -Point Circle and Ellipse Algorithms. Filled Area Primitives, Polygon Filling Algorithms. Curve Generation: Bezier and B-Spline Curves.

ModuleII: 2D Geometric Transformations

Translation, Rotation, Scaling, Reflection and Shear Transformations, Matrix representation and homogenous coordinates, Composite transformation, Interactive picture construction Techniques.

ModuleIII:2D Viewing

The Viewing Pipeline, Viewing Coordinate Reference Frame, Window to Viewport Coordinate Transformation, Viewing Functions.
Line Clipping Algorithms, Polygon Clipping Algorithms.

Unit III:Three-dimensional concepts

Three dimensional display methods, 3-D Object Representations Polygon surfaces, Quadric Surfaces, Spline Representation, Sweep representations, Constructive solid geometry methods, Octrees and Quadtrees.

ModuleV:3-D Geometric Transformations

Translation, Rotation, Scaling, Reflection and Shear Transformations, Composite Transformations

Module VI:3-D Viewing

Viewing Pipeline, Viewing Coordinates, View Volume, General Projection Transforms and Clipping.

Module VII:Visible Surface Detection Methods

Classification, Back -Face Detection, Depth- Buffer, Scanline, Depth Sorting, BSP-Tree Methods, Area Sub-Division and Octree Methods

ModuleVIII:Illumination Models and Surface Rendering Methods

Basic Illumination Models, Polygon Rendering Methods Computer Animation: Design of Animation Sequence, General Computer Animation Functions, Key Frame Animation, Animation Sequence, Motion Control Methods, Morphing, Warping.

References

1. *Donald D. Hearn & M. Pauline Baker, Computer Graphics C Version, Second Edition,, PHI.*
2. *Donald Hearn and M. Pauline Baker, "Computer Graphics with Open GL", Prentice Hall. R. K Maurya, "Computer Graphics with Virtual Reality", Wiley.*
3. *Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles & practice", Pearson Education.*
4. *Newman W M & R F Sproul, Principles of Interactive Computer Graphics, Second Edition Mc-Graw Hill Publishers.*

IMSE606CS-3 Fuzzy and Evolutionary Computing

Credits 2(2-1-0)

Module I:Fuzzy Logic

Fuzzy Versus Crisp – Crisp sets – Operations on Crisp Sets, Properties of Crisp Sets, Fuzzy Sets, Basic Fuzzy Set Operations, Properties of Fuzzy Sets

Module II:Crisp Relations

Operations on Crisp Relations - Fuzzy Relations –Operations on Fuzzy Relations, Properties, Membership Functions, Fuzzification, Defuzzification Methods.

ModuleIII:Fuzzy Systems

Fuzzy Rule Base- Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Logic Control Systems, Applications.

ModuleIV:Genetic Algorithms

Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques– Biological Background – Contrast with Traditional Methods, Terminologies, Operators – Encoding – Selection- Crossover- Mutation– Fitness Function – Reproduction- Advantages, Limitations and Applications of Genetic Algorithms.

ModuleV:Solvingsingle-objective optimization problems using GAs

Concept of multi-objective optimization problems and issues of solving them, Multi-Objective Evolutionary Algorithms.

References

1. *F. Martin, , Mc neill, and Ellen Thro, Fuzzy Logic: A Pratical approach, , AP Professional.*
2. *Melanie Mitchell, An Introduction to Genetic Algorithms, MIT Press.*
3. *John Yen, Reza Langari, Fuzzy Logic –Intelligence, Control and Information, Pearson Education.*
4. *S. Rajasekaran, G.A VijayalakshmiPai, Neural Networks, Fuzzy Logic, and Genetic Algorithms-Synthesis and Applications, Prentice-Hall of India Pvt.Ltd.*
5. *David E. Goldberg, Genetic Algorithms In Search, Optimization And Machine Learning, Pearson Education.*
6. *Randy L. Haupt and sue Ellen Haupt, Practical Genetic Algorithms, John Willey & Sons.*
7. *S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, , Wiley India.*
8. *Dilip Kumar Prathihar, Soft Computing, Alpha Science International.*

Environmental Science Major (Core courses)

IMSC406ES Inorganic Chemistry Lab-1

Credits 2(0-0-6)

Volumetric Analysis: Introduction - Primary and secondary standards – Standard solutions - Theory of titrations involving acids and bases, KMnO4, K2Cr2O7, I_2 and liberated I_2 – Complex metric titrations. Indicators: Theory of acid-base, redox, adsorption and complex metric indicators. Double burette method of titration: Principle and advantages.

2. Volumetric analysis
   a .Acidimetry and alkalimetry:
   Titration of Strong acid – strong base, Strong acid – weak base , Weak acid – strong base titrations Estimation of NaHCO3 and Na2CO3 in a mixture , Estimation of NH3 by indirect method.
   b. Redox titrations
   Permanganometry – 1. Estimation of oxalate, 2. Estimation of Calcium 3 . Estimation of nitrate 4. Estimation of Ferrous iron b) Dichrometry – 1. Estimation of Fe2+ - external and internal indicators. 2. Estimation of Fe3+ (after reduction) c) Iodimetry and Iodometry – 1. standardisation of sodium thiosulphate using potassium iodate, Electrolytic copper and potassium dichromate 2. Estimation of As2O3 and arsenite 3. Estimation of copper sulphate.
   c. Complexometric titrations 1. Estimation of Zinc 2. Estimation of Magnesium 3. Estimation of Calcium.

3 Ion Exchange Method: Separation and estimation of Mg(II) and Zn(II)

4 Solvent extraction: Separation and estimation of Mg(II) and Fe(II)

5 Practical application of titrations in common life

g. Determination of acetic acid content in Vinegar by titration with NaOH.
h. Determination of alkali content in antacid tablets by titration with HCl.
i. Determination of copper content is basis by Iodometric titration.
j. Determination of available chlorine in bleaching powder.
k. Determination of COD of water samples
l. Determination of hardness of water

References:

1. *G. Svehla: Vogel's Qualitative Inorganic Analysis.*
2. *J. Mendham, R. C. Denny, M. J. K. Thomas: Vogel's Text Book of Quantitative Chemical Analysis.*
3. *Vogel's Textbook of Quantitative Chemistry.*
4. *Synthesis & characterization of Inorganic Compounds by W. L. Jolly, Prentice Hall. Lab Skills*

IMSC407ES Water Quality Analysis

Credits 2(0-0-6)

Water sampling – surface water and ground water

Sample preservation

Water quality analysis- Physical and chemical parameters – transparency, temperature, colour, turbidity, pH, Solids – total, suspended and dissolved, conductivity

References:

1. *APHA (1995). Standard methods for the examination of water and wastewater. 19th edition American Public Health Association, Washington, DC*
2. *Mamata Tomar, Quality Assessment of Water and Waste Water, Lewis Publishers London*
3. *Abbasi S A, Water quality sampling and analysis, Discovery Publishing New Delhi*
4. *Christian Gary D, Analytical Chemistry, JhonWiley & Sons NewYork*

IMSC501ES Ecology and Biodiversity Conservation

Credits 3(3-1-0)

Module I: Introduction
Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, biomes of the world. Ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypicplasticity; ecotypes; ecoclines; acclimation; ecological niche; strategies of adaptation in plants and animals.concept and types of speciation.

ModuleII: Ecology of Populations
Concept of population and meta-population; r- and K-selection; characteristics of population: density,dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth:geometric, exponential, logistic, density-dependent; limits to population growth; deterministic andstochastic models of population dynamics; rudreal, competitive and stress-tolerance strategies.

Module III: Ecology of Communities
community structure and organization: species associations, keystone species, ecotone and edgeeffect; species interactions: mutualism, symbiotic relationships, commensalism, amensalism,protocooperation, predation, competition, parasitism, mimicry, herbivory; ecological succession:primary and secondary successions, models and types of successions, climax community concepts,examples of succession.

ModuleIV: Biodiversity
Introduction to biodiversity, From genes to ecosystems; tree of life; history of character transformation; organic evolution throughgeographic time scale; species concept Levels of Biodiversity; Geneticdiversity,speciesdiversity,Eco-systemdiversity, alpha, beta, gamma. Global and Regionalbiodiversity

Module V: Biodiversity Estimation
Sampling strategies and surveys: floristic, faunal, and aquatic; qualitative and quantitative methods:scoring, habitat assessment, richness, density, frequency, abundance, evenness, diversity, biomass estimation; community diversity estimation: alpha, beta and gamma diversity; molecular techniques:RAPD, RFLP, AFLP; NCBI database, BLAST analyses.

ModuleVI: Values and Threats of Biodiversity
Economic values; ecological and ecosystem services; Cultural social, aesthetic, consumptive and ethical values of biodiversity. Threats : Natural and anthropogenic disturbances; habitat loss, habitat degradation and habitat fragmentation; invasive species; Pollution; climate change; pollution; hunting; over-exploitation; deforestation; developmental activities; land use changes; overgrazing; man wildlife conflicts; consequences of biodiversity loss.

ModuleVII: Conservation of Biodiversity
In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries); Ex-situ conservation(botanical gardens, zoological gardens, gene banks, seed and seedling banks, pollen culture, tissueculture and DNA banks), role of local communities and traditional knowledge in conservation;biodiversity hotspots; IUCN Red List categorization – guidelines, practice and application; Red Databook; ecological restoration; afforestation; social forestry; agro forestry; joint forest management; role of remote sensing in management of natural resources.

ModuleVIII: Biodiversity in India
India as a mega diversity nation; phytogeographic and zoogeographic zones of the country; forest types and forest cover in India; fish and fisheries of India; impact of hydropower development on biological diversity; status of protected areas and biosphere reserves in the country; National Biodiversity Action Plan.Legal aspects of conservation in India – Biodiversity Rules and Act.

References

1. *Groom. B. & Jenkins. M. 2000.Global Biodiversity: Earth's Living Resources in the 21stCentury. World Conservation Press, Cambridge, UK.*
2. *Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. The Ecology of Plants. Sinauer associatesincorporated.*
3. *Loreau, M. &Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis andPerspectives. Oxford University Press, Oxford, UK.*
4. *Odum, E.P. 1971. Fundamentals of Ecology. W.B. Sounders.*

5. *Sutherland,W.J.2004.TheConservationHandbook,Research,ManagementandPolicy,BlackwelScienceltd.P278.*
6. *MichaelE.SouleandBruceWilcox,1980.ConservationBiology:AnEvolutionaryEcologicalPerspective.*
7. *Lewis,M.2003.InventingGlobalEcology:Trackingthebiodiversityidealin India, OrientLongman.P369.*
8. *Martin,G.J.1995.Ethnobotany-Amethodsmanual.Chapman&Hall.Madras.*
9. *Maxted,N.,B.V.Ford-LloydandJ.G.Hawkes.1997.PlantGeneticconservation-theinsituapproach.Chapman&Hall,Madras.*
10. *Ahmadullah,MandNayar,M.P.1987.EndemicplantsoftheIndianRegion.Vol.IBotanicalSurveyofIndia.*
11. *Heywood,V.H. (Ed.) 1995.GlobalBiodiversityAssessment (UNEP),Cambridge UniversityPress,Cambridge.*
12. *Gaston, K J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London,UK.*
13. *Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles andPractices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.*
14. *Primack, R.B. 2002. Essentials of Conservation Biology (3rd edition). Sinauer Associates,Sunderland, USA.*
15. *Singh, J. S. & Singh, S. P. 1987. Forest vegetation of Himalaya. The Botanical Review **53**:80-192.*
16. *Singh, J. S., Singh, S.P. & Gupta, S. 2006. Ecology, Environment and Resource Conservation.Anamaya Publications, New Delhi.*
17. *Sodhi, N.S. & Ehrlich, P.R. (Eds). 2010. Conservation Biology for All. Oxford UniversityPress.*
18. *Sodhi, N.S., Gibson, L. & Raven, P.H. 2013. Conservation Biology: Voices from the Tropics.Wiley-Blackwell, Oxford, UK.*

IMSC502ES Water Resources

Credits 3(3-1-0)

Module I: Introduction

Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapotranspiration; classification of water resources (oceans, rivers, lakes and wetlands).

Module II: Surface and Subsurface

Introduction to surface and ground water; Properties of water**;**surface and ground water pollution; water table; formation and properties of aquifers; techniques for ground water recharge; river structure and patterns; watershed and drainage basins; importance of watershed and watershed management; rain water harvesting in urban settings.

Module III: Wetlands and Their Management

Definition of a wetland; types of wetlands (fresh water and marine); ecological significance of wetlands; threats to wetlands; wetland conservation and management; Ramsar Convention, 1971; major wetlands of India.

ModuleIV: Water resources of Kerala

Surface water resources- lakes, rivers, wetlands, estuaries, Dams; Ground water resources of Kerala; Water budget of Kerala; Threats to water resources; Rainwater harvesting; Traditional water harvesting practices;

Module V: Water resource in India

Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; hot spots of surface water; Traditional water harvesting systems in India**,** role of state in water resources management.

Module VI: Water resources Conflicts

Water resources and sharing problems, case studies on Kaveri and Krishna river water disputes; Multipurpose river valley projects in India and their environmental and social impacts; case studies of dams - Narmada and Tehri dam – social and ecological losses versus economic benefits; International conflicts on water sharing between India and her neighbours; agreements to resolve these conflicts. Laws related to water resources

References

1. *Bansil, P.C. 2004. Water Management in India. Concept Publishing Company, India.*
2. *Brebbia, C.A. 2013. Water Resources Management VII. WIT Press.*
3. *Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. Water Resource Systems Planning and Analysis. Englewood Cliffs, NJ, Prentice Hall.*
4. *Mays, L.W. 2006. Water Resources Sustainability. The McGraw-Hill Publications.*
5. *Schward& Zhang, 2003. Fundamentals of Groundwater. John Willey and Sons.*
6. *Vickers, A. 2001. Handbook of Water Use and Conservation. Water Plow Press*

IMSC503ES Environmental Pollution

Credits 3(3-1-0)

ModuleI: Introduction
Definition of pollution; pollutants; classification of pollutants.

Module II: Air Pollution
Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on human health (NOx, SOx, PM, CO, CO2, hydrocarbons and VOCs) and control measures; indoor air pollution: sources and effects on human health.

Module III: Water Pollution
Sources of surface and ground water pollution; water quality parameters and standards; organic waste and water pollution; eutrophication; COD, BOD, DO; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs).

Module IV: Soil Pollution
Causes of soil pollution and degradation; effect of soil pollution on environment, vegetation and other life forms; control strategies.

Module V: Noise Pollution
Noise pollution – sources; frequency, intensity and permissible ambient noise levels; effect on communication, impacts on life forms and humans - working efficiency, physical and mental health; control measures.

Module VI: Radioactive and Thermal Pollution
Radioactive material and sources of radioactive pollution; effect of radiation on human health (somatic and genetic effects); thermal pollution and its effects.

ModuleVII: Chemistry of Environmental Pollutants
Solubility of pollutants (hydrophilic and lipophilic pollutants), transfer of pollutants within different mediums, role of chelating agents in transferring pollutants, concept of biotransformation and bioaccumulation, concept of radioactivity, radioactive decay and half-life of pollutants, organometallic compounds, acid mine drainage.

Reference

1. *Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. Air Pollution: Health and Environmental Impacts. CRC Press, Taylor & Francis.*
2. *Hester,R.E. & Harrison, R.M. 1998. Air Pollution & Health. The Royal Society of Chemistry, UK.*
3. *Park,K. 2015. Park's Textbook of Preventive & Social Medicine (23 rd edition). Banarsidas Bhanot Publishers.*
4. *Pepper, I.L. Gerba, C.P. &Brusseau, M.L. 2006. Environmental & Pollution Science. Elsevier Acad. Press.*
5. *Purohit, S.S. & Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.*
6. *Vesilind, P.J.,Peirce J.J. & Weiner R.F. 1990. Environ. Pollution & Control. Butterworth-Heinemann, USA.*

IMSE504ES Energy Resources

Credits 3(2-1-0)

Module I: Introduction
Defining energy; forms and importance; energy use from a historical perspective: discovery of fire, discovery of locomotive engine and fossil fuels, electrification of cities, oil wars in the Middle East, advent of nuclear energy; sources and sinks of energy; energy over-consumption in urban setting

Module II: Energy Resources
Global energy resources; renewable and non-renewable resources: distribution and availability; past, present, and future technologies for capturing and integrating these resources into our energy infrastructure; energy-use scenarios in rural and urban setups; energy conservation.

ModuleIII: Energy Demand
Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sector; generation and utilization in rural and urban

environments; changes in demand in major world economies; energy subsidies and environmental costs.

Module IV: Energy, Environment and Society

Nature, scope and analysis of local and global impacts of energy use on the environment; fossil fuel burning and related issues of air pollution, greenhouse effect, global warming and, urban heat island effect; nuclear energy and related issues such as radioactive waste, spent fuel; social inequalities related to energy production, distribution, and use.

Module V: Energy, Ecology and Environment

Energy production as driver of environmental change; energy production, transformation and utilization associated environmental impacts (Chernobyl and Fukushima nuclear accidents, construction of dams, environmental pollution); energy over-consumption and its impact on the environment, economy, and global change.

References

1. *McKibben, B. 2012. Global Warming's Terrifying New Math, Rolling Stone Magazine.*
2. *Craig. J.R., Vaughan, D.J., Skinner. B.J. 1996. Resources of the Earth: Origin, use, and environmental impact (2nd edition). Prentice Hall, New Jersey.*
3. *Elliott, D. 1997. Sustainable Technology. Energy, Society & Environment (Chapt 3) New York, Routledge Press.*
4. *Mallon, K. 2006. Myths, Pitfalls and Oversights, Renewable Energy Policy and Politics: A Handbook for Decision-Making. EarthScan.*

IMSC505ES Ecology Lab

Credits 2(0-0-6)

1. Study through specimens/photographs/slides of interactions : Parasitic angiosperms, Saprophytic angiosperms, VAM fungi, Root nodules, Corolloid roots, Mycorrhizal roots, Velamen roots, Lichen as pollution indicators.
2. To determine a minimal quadrat area for sampling in the given simulation sheet
3. 3.To determine density/frequency/abundance of the vegetation by quadrat method in the field or on given simulation sheet
4. Microscopic identification of common freshwater phyto and zooplanktons
5. 5.To estimate the primary productivity of the aquatic ecosystem using dark and light bottle method.

References

1. *Daniel, J.C. 2002. The Book of Indian Reptiles & Amphibians, Oxford Univ. Press, Mumbai*
2. *Daniels, R.J. R. 2002. Freshwater Fishes of peninsular India. Universities press (India) Private Ltd. Hydrbd.*

IMSC506ES Inorganic Chemistry lab -2

Credits 2(0-0-6)

Principles in the separation of cations in qualitative analysis - Applications of common ion effect and solubility product - Microanalysis and its advantages.

1. Qualitative inorganic analysis of mixtures containing not more than 4 radicals (two cations and two anions) from the following:
2. Cation Radicals, NH_4^+, Ca^{+2}, Sr^{+2}, Ba^{+2}, Al^{+3}, Cr^{+3}, Mn^{+2}, Fe^{+3}, Co^{+3}, Ni^{+2}, Cu^{+2}, Zn^{+2} Mg^{+2} Pb^{+2}. Anion Radicals: CO_3^{2-} $C_2O_4^{2-}F^-$, Cl^-, Br-, Br^- , I^-, SCN^-, S^{2-}, SO_4^{2-}, $S_2O_3^{2-}$, NO_3^-, PO_4^{3-}, $B_2O_3^{3-}$, $CrO_4^{2-}/Cr_2O_7^{2-}$,SO_4^{2-} Insoluble Materials: Al2O3, Fe2O3, Cr2O3, SnO2, SrSO4, BaSO4, CaF2.

Experiment A: Preliminary Tests for acid and basic radicals in given samples.

Experiment B: Wet tests for Acid and Basic radicals in given samples.

Experiment C: Identification and Confirmatory tests.

3. Preparation of some Inorganic compounds and its characterization using UV-VIS, IR spec.

Mohr Salt from Kipp'swaste ,Nickel dimethyl glyoximate, Potassium trisoxalato ferrate (III) , Tristhioureacopper (I) sulphate, Tetraammine copper (II) sulphate etc.

4. Colorimetry/spectrophotometry: Verification of Beer-Lambert law for KMnO4 and K2Cr2O7 & determination of concentration of the given solution. (a) . Estimation of iron. (b). Estimation of chromium(c). Estimation of nickel

References:

1. *Vogel's Textbook of Quantitative Chemistry.*
2. *Synthesis & characterization of Inorganic Compounds by W. L. Jolly, Prentice Hall.*
3. *Vogel's Text book of Macro &Semimicro Qualitative Analysis*

IMSC601ES Basics of Environmental Biotechnology

Credits 3(3-1-0)

ModuleI: Structure and Function of DNA, RNA and Protein

DNA: Double helical structure and different forms of DNA (B, A, C, D, T, Z) , their characteristics; physical properties: UV absorption spectra, denaturation and renaturation kinetics; biological significance of different forms; DNA Synthesis.

RNA:structural forms and their characteristics (rRNA, mRNA, tRNA; SnRNA, Si RNA, miRNA, hnRNA); biological significance of different forms ; RNA synthesis.

Protein: Structure (primary, secondary, tertiary, quaternary), types of amino acids; posttranslational modifications and their significance; Protein synthesis; types of proteins : Structural and functional proteins (Enzymes) and their role in cell metabolism.

Central dogma of biology; genetic material in prokaryotes, viruses, eukaryotes and organelles; mobile DNA; chromosomal organization (euchromatin, heterochromatin - constitutive and facultative heterochromatin).

Module II: Recombinant DNA Technology

Recombinant DNA: origin and current status; steps of preparation; toolkit of enzymes for manipulation of DNA: restriction enzymes, polymerases (DNA/RNA polymerases, transferase, reverse transcriptase), other DNA modifying enzymes (nucleases, ligase, phosphatases, polynucleotide kinase); genomic and cDNA libraries: construction, screening and uses; cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes; nucleic acid microarrays

ModuleIII: Waste management and Bioremediation

Solid and liquid waste management; Wastewater treatment: basics; solid waste treatment: sources, waste processing (composting, vermicomposting) and disposal (landfill); Bioremediation –oil spills and superbug ; phytoremediation; Xenobiotics : impacts on environment and bioremediation of Xenobiotics.

Module IV: Ecologically Safe Products and Processes

Plant growth-promoting rhizobacteria (PGPR) and their role in Agriculture; biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management (IPM); development of stress tolerant plants. Biodegradable plastics.

References

1. *Evans, G.G. & Furlong, J. 2010. Environmental Biotechnology: Theory and Application (2nd edition). Wiley-Blackwell Publications.*
2. *Jordening, H.J. & Winter J. 2005. Environmental Biotechnology: Concepts & Applications. John Wiley& Sons.*
3. *Lodish, H.F., Baltimore, D., Berk, A. Zipursky, S.L. Matsudiara, P. & Darnell, J. 1995. Molecular Cell Biology. W.H. Freeman.*
4. *Nelson, D.L. & Cox, M.M. 2013. Lehninger's Principles of Biochemistry. W.H. Freeman.*
5. *Rittman, B.E. & McCarty, P.L. 2001. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York.*
6. *Scagg, A.H. 2005. Environmental Biotechnology. Oxford University Press.*
7. *Snustad, D.P. & Simmons, M.J. 2011. Principles of Genetics (6th edition). John Wiley& Sons.*
8. *Wainwright, M. 1999. An Introduction to Environmental Biotechnology. Springer.*

IMSC602ES Biogeochemistry

Credits 3(3-1-0)

Module I: Introduction

Earth as a biogeochemical system, Origins of the elements, Earth evolution-Prebiotic Earth and mineral cycles, Origin of life

Module II: Biogeochemical Cycles

Lithosphere, cryosphere, Carbon cycle- terrestrial and marine environment

ModuleIII: Nutrient Cycles

Nutrient cycles-nitrogen cycle; phosphorus cycle; nutrient cycle models; ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake; decomposition and nutrient release; nutrient use efficiency; nutrient budget; nutrient conservation strategies.

Module IV: Elemental Cycles

Toxic metal cycles – mercury, lead, cadmium ; Global sulphur cycle; sulphur geochemistry in freshwater and marine water systems, hydrothermal vents; Microbes in biogeochemistry, Stable isotopes and biogeochemistry, stable C and N isotopes in biogechemistry

Module V: Sediment Biogeochemistry

Global water cycle; Ocean circulation , Biogeochemical reactions in troposphere and stratosphere, atmosphere in elemental cycles; Marine sediments –origin and process, sedimentary record of biogeochemistry

Module VI: Biogeochemistry of Freshwater and Barckishwater Ecosystems

Biogeochemistry in Freshwater Wetlands and Lakes; redoxpotential and reactions in natural environments; Biogeochemistry of Rivers and Estuaries

References

1. *DeLaune, Ronald D and Ramesh Reddy, K., Biogeochemistry of wetlands: science and applications, London, CRC Press ; 2008*
2. *Bianchi, Thomas S., Biogeochemistry of Estuaries, Newyork, Oxford ; 2006*
3. *Bormann, F Herbert, Likens, Gene E., Biogeochemistry of a Forested Ecosystem, Springer verlag*
4. *Sharma, B K., Environmental chemistry, Goel Publishing House ; 2006*
5. *Barrett, Gary W and Odum, Eugene P., Fundamentals of Ecology, Thomson Books Cole ; 2006*
6. *Schlesinger, W.H., Biogeochemistry: An analysis of global change, Elsevier, 2013.*
7. *Cronan, Christopher S.,Ecosystem Biogeochemistry-Element Cycling in the Forest Landscape, Springer*

IMSC603ES Climate Change

Credits 3(3-1-0)

Module 1: Global Energy Balance

Earth's energy balance; energy transfers in atmosphere; Earth's radiation budget; green house gases (GHGs); greenhouse effect; global conveyor belt.

Module 2: Atmospheric Circulation

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; El Nino and La Nina; tropical cyclone; Indian monsoon and its development, changing monsoon in Holocene in the Indian subcontinent, its impact on agriculture and Indus valley civilization; effect of urbanization on micro climate; Asian brown clouds.Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation)

Module 3: Global Warming and Climate Change

Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different green house gases (GHGs) causing the climate change; atmospheric windows; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO2 fertilization and agriculture; impact on economy and spread of human diseases.

Module 4: Ozone Layer Depletion

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures and international protocols.

Module 5: Climate Change and Policy

Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

References

1. *Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.*
2. *Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentarieswith Policy andScience Considerations. Martinus Nijhoff Publishers.*
3. *Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.*
4. *Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.*
5. *Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.*
6. *Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.*
7. *Mathez, E.A. 2009. Climate Change: Science of Global Warming and our Energy Future. Columbia Uni, Press*
8. *Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate and India. Universities Press, India.*
9. *Philander, S.G. 2012. Encyclopedia of Global Warming & Climate Change (2nd edition). Sage Publications.*

IMSC604ES Soil & Water Quality Analysis-Lab

Credits 2(0-0-6)

Soil – temperature,Water infiltration capacity, texture, bulk density,Organic carbon, moisture content, Water quality analysis- chemical parameters - pH, acidity, alkalinity, chloride, salinity, hardness, DO

References:

1. *APHA (1995). Standard methods for the examination of water and wastewater. 19th edition American Public Health Association, Washington, DC*
2. *Maiti, S.K. (2003) Handbook of methods in environmental studies, Vol. 2: Air, noise, soil, overburden, solid waste and ecology. ABD Publishers, Japur.*
3. *Marc Pansu, Jacques Gautheyrou, Hand book of soil analysis- Minerological, organic and inorganic methods, Springer, New York*
4. *Miroslav Radojevic and Vladimir N Bashkin, Practical Environmental Analysis, RSC Publishing*
5. *Conklin Alfred R. Introduction to Soil chemistry, analysis and Instrumentation, Jhonwiley&Sons Newyork*
6. *Mamata Tomar, Quality Assessment of Water and Waste Water, Lewis Publishers London*
7. *Abbasi S A, Water quality sampling and analysis, Discovery Publishing New Delhi*

IMSC605ES Air Analysis & Remote Sensing and GIS-Lab

Credits 2(0-0-6)

Air quality parameters - Particulate matter – PM 2.5 and PM 10; Noise analysis

Remote sensing and GIS:

Introduction to Base maps and how to read the map using map elements
Toposheet numbering
Components of GIS
Software's used in GIS
Georefrencing toposheet
Vectorisation using GIS software's
Vector based analysis in GIS
Satellite images - Band stacking
FCC visualization in software's

References:

1. *Maiti, S.K. (2003) Handbook of methods in environmental studies, Vol. 2: Air, noise, soil, overburden, solid waste and ecology. ABD Publishers, Japur.*
2. *Miroslav Radojevic and Vladimir N Bashkin, Practical Environmental Analysis, RSC Publishing*
3. *NEERI , Air quality monitoring, A course manual (Photostat), NEERI Nagpur*

Environmental Science Major (Elective courses)

IMSE408ES-1 Green chemistry

Credits 2(2-1-0)

Module I: Introduction to Green Chemistry
What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

ModuleII: Principles of Green Chemistry and Designing a Chemical synthesis
Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following

Module III:Designing a Green Synthesis
using these principles; Prevention of Waste/ byproducts;maximum incorporation of the materials used in the process into the final products ,Atom Economy, alculation of atom economy of the rearrangement, addition,substitution and elimination reactions. Prevention/ minimization of hazardous/ toxic products reducing toxicity.risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

ModuleIV:Green solvents
supercritical fluids, water as a solvent for organic reactions, ionicliquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solventsand how to compare greenness of solvents.

ModuleV:Energy requirements for reactions
Alternative sources of energy: use of microwaves and ultrasonic energy. Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.
Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Module VI: Examples of Green Synthesis

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction

ModuleVII: Future Trends in Green Chemistry
Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

References:

1. *Ahluwalia, V.K. &Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005).*
2. *Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998).*
3. *Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).*
4. *Cann, M.C. &Connely, M.E. Real-World cases in Green Chemistry, ACS, Washington (2000).*
5. *Ryan, M.A. &Tinnesand, M. Introduction to Green Chemistry, ACS, Washington (2002).*
6. *Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition,2010.*

IMSE408ES-2 Environmental Legislation

Credits 2(2-1-0)

Module I: Introduction
Constitution of India; fundamental rights; fundamental duties; Union of India; union list, state list, concurrent list; legislature; state assemblies; judiciary; panchayats and municipal bodies; National Green Tribunal.

Module II: History of Environmental Legislation and Policy
Ancient period, British India: Indian Penal Code 1860,Forest Act 1865, Fisheries Act 1897; Independent India: Van Mahotsava 1950, National Forest Policy 1952, Orissa River pollution &prevention Act 1953.

Module III: Environmental Legislation
Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties). The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988; The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002; The Schedule Tribes and other Traditional Dwellers (Recognition of Forests Rights) Act 2006; The National Green Tribunal Act 2010; scheme and labeling of environment friendly products, Ecomarks.

Module IV: Government Institutions
Role of Ministry of Environment, Forests & Climate Changein environmental law and policy making; role of central and state pollution control boards in environmental law and policy
Case studies : National Green Tribunal: Aditya N Prasad vs. Union of India & Others; Ganga Tanneries Case: M.C. Mehta vs. Union of India 1988; environmental education case: M.C. Mehta vs. Union of India, WP 860/1991.

Module V: Environmental Education
History and types- Formal and informal education; Environmental education in India

Reference

1. *Abraham, C.M. 1999. Environmental Jurisprudence in India. Kluwer Law International.*
2. *Agarwal, V.K. 2005. Environmental Laws in India: Challenges for Enforcement. Bulletin of theNational Institute of Ecology 15: 227-238.*
3. *Divan, S. & Rosencranz, A. 2001. Environmental Law and Policy in India. Oxford UniversityPress.*
4. *Divan, S. & Rosencranz, A. 2002. Environmental Law and Policy in India: Cases, Materialsand Statues (2nd edition). Oxford University Press.*
5. *Gupta, K.R. 2006. Environmental Legislation in India. Atlantic Publishers and Distributors.*
6. *Leelakrishnan, P. 2008. Environmental Law in India (3rd edition). LexisNexis India.*
7. *Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International.*
8. *Venkat, A. 2011. Environmental Law and Policy. PHI Learning Private Ltd.*

IMSE408ES-3 Natural Resources

Credits 2(2-1-0)

Module I: Introduction
Resource and reserves; classification of natural resources; renewable and non-renewable resources; resource degradation; resource conservation; resource availability and factors influencing its availability; land resources; water resources; fisheries and other marine resources; energy resources; mineral resources; human impact on natural resources.

Module II: Forest resources
Forest resources: economic and ecological importance of forests, forest management strategies, sustainable forestry; Forest of Kerala and India

Module III: Water and soil resources
Water resources- surface and ground water, soil as a resource; food resources: world food problem, techniques to increase world food production.

Module IV: Mineral Resources
Mineral resources and the rock cycle; identified resources; undiscovered resources; reserves; types of mining: surface, subsurface, open-pit, dredging, strip; reserve-to-production ratio; global consumption patterns of mineral resources techniques to increase mineral resource supplies; ocean mining for mineral resources.

Module V: Marine Resource Management
Marine resources; commercial use of marine resources; threats to marine ecosystems and resources; marine ecosystem and resource management (planning approach, construction techniques and monitoring of coastal zones).

References

1. *Craig, J.R., Vaughan. D.J. & Skinner. B.J. 1996. Resources of the Earth: Origin, Use, and Environmental Impacts (2nd edition). Prentice Hall, New Jersey.*
2. *Freeman, A.M. 2001. Measures of value and Resources: Resources for the Future. Washington DC.*
3. *Freeman, A.M. 2003. Millennium Ecosystem Assessment: Conceptual Framework. Island Press.*
4. *Ginley, D.S. & Cahen, D. 2011. Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge University Press.*
5. *Klee, G.A. 1991. Conservation of Natural Resources. Prentice Hall Publication.*
6. *Miller, T.G. 2012. Environmental Science. Wadsworth Publishing Co.*
7. *Owen, O.S, Chiras, D.D, & Reganold, J.P. 1998. Natural Resource Conservation –Management for Sustainable Future (7th edition). Prentice Hall.*

IMSE507ES-1 Biochemistry

Credits 2(2-1-0)

Module I: Chemistry of biomolecules and natural products
Basic aspects(structure, chemistry and bonding),carbohydrates, amino acids and proteins, nucleic acids,terpenoids,alkaloids, fatty acids,steroids, plant pigments, lipids, and vitamins. Nomenclature of prostaglandins.Methods for primary structure determination of peptides, proteins and nucleicacids.

Module II: Reactions and concepts in protein chemistry.
Concept of supramolecular assembliesbased on structural aspects-example proteins (enzymes) and biomembrane assemblies.

Module III: Biocatalysis
with respect to conformations and structure and function relationship, enzymecatalysis, vitamins as co-factors, enzyme kinetics, graphical evaluation of KM and Vmax, enzymeinhibition, mechanisms regulatory aspects.

Module IV: Metabolism
overview and selected individual and important oxidative pathways.Glycolysis, TCA cycle-pentose phosphate pathway. Citric acid cycle: energetic and amphibolicnature. Regulatory aspects of TCA cycle and glycolysis. Photosynthetic electron transport andphosphorylation and CO2 fixation.

Module V: Transfer of genetic information
Chemistry of nucleic acids, nucleotide, nucleoside, cyclicAMP, assembly of DNA, types of RNA. Replication of DNA, flow of genetic information, protein biosynthesis,transcription and translation, Genetic code, regulation of gene expression, DNAsequencing. The Human Genome Project. DNA profiling and the PolymeraseChain Reaction (PCR).Repair ofDNA and recombinant DNA concept.

References

1. *A. Lehninger, Principles of Biochemistry, CBS Publishers, 1990.*
2. *R.W. McGilvery, G.W. Goldstein, Biochemistry: a Functional Approach, 3rd Edn.,Saunders, 1983.*
3. *G. Zubay, Biochemistry, 2nd Edn.,MacGraw Hill Ryerson, 1999.*
4. *P.S. Kalsi, Chemistry of Natural Products, Kalyani Publishers, 2001.*
5. *S.V. Bhat, B.A. Nagasampagi, M. Sivakumar, Chemistry of Natural Products, Springer, 2005*
6. *D.E. Metzler, Biochemistry: The Chemical Reactions of Living Cells, Academic Press, 2001.*

IMSC507ES-2 Human-wildlife conflict

Credits 2(2-1-0)

Module I: Wildlife Resources of India with special reference to Kerala
Definition of wildlife, Brief account of mammals, birds, herpetofauna, fishes, invertebrates of Kerala, IUCN status.

Module II:Human-Wildlife Conflicts
Basic concepts, reason for conflicts, Identification of damages caused by wild animals and control measures. Case studies – Elephant, gaur, wild boar, monkey, tiger and leopard, Translocation of Wild animals – Principles, Methods and application.Human wildlife co existence, traditional knowledge in wildlife conservation.

Module III:Wildlife management
Threats and conservation issues (poaching, habitat loss, habitat fragmentation and habitat degradation, roadside kills, alien species, pollution, other anthropogenic activities, endemism etc.). Population estimation of wildlife - Basic concepts and applications - Direct count (block count, transect methods, Point counts, visual encounter survey, waterhole survey). Indirect count (Call count, track and signs, pellet count, pugmark, camera trap, DNA finger printing and aerial photography).

Module IV: Wildlife conservation laws in India
Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range, brief introduction to Wildlife Protection Act of 1972, Forest act 1927, Environmental Protection Act 1986, and Forest conservation Act 1920; introduction of Tiger task force, Status of current protected areas in India.

References

1. *Daniel, J.C. 2002. The Book of Indian Reptiles & Amphibians, Oxford Univ. Press, Mumbai*
2. *Daniels, R.J. R. 2002. Freshwater Fishes of peninsular India. Universities press (India) Private Ltd. Hyderabad*
3. *Dasmann, RF. 1964. Wildlife Biology. John and Wiley and sons Newyork. P-231.*
4. *Giles, R.H. Jr. (Ed) 1984. Wildlife Management Techniques 3rd edition. The wildlife*
5. *Menon, V. 2003. A Field Guide to Indian Mammals. Dorling Kindersley (India) Pvt.Limited*
6. *Saharia, V.B. 1982. Wildlife in India, Nataraj Publishers, Dehra Dun*
7. *Seshadri, B.1986. India's Wildlife reserves , Sterling Pub'rs Pvt. Ltd., New Delhi*
8. *Thomas, A.P. (Ed) 2013. Biodiversity Scope&Challenges. Green leaf Publications,Kottayam*
9. *Tripheron, C.A. and Johnson, N.F. 2005. Borror and Delong's Introduction to the Study of Insects. Brooks/Cole Ceanage Learning Ltd.*

IMSE606ES-1 Nanomaterials

Credits 2(2-1-0)

Module I: Introduction to nanomaterials
Emergence of nanotechnology,defining nanodimensional materials, size effects innanomaterials , Moore's law, , physical and chemical methods of synthesis of nanomaterials,synthesis and properties of fullerenes and carbon nanotubes,synthesis of nanoparticles of gold, silver, rhodium, palladium and platinum,techniques of synthesis-electroplating and electrophoretic deposition, conversionthrough chemical reactions and lithography. Thin films-chemical vapor depositionand atomic layer deposition techniques,

Module II: Diversity in nanosystems
Nanofabricationmethods: top-down and bottom-up methods, self assembled monolayers on gold-growth processand phase transitions. Gas phase clusters- formation, detection and analysis.quantum concepts.Quantum dots- preparation, characterization and applications. Nanoshells-types ofsystems, characterization and application.

Module III: Interfaces of nanotechnology
Nanobiology, nanosensors, nanomedicines.Types of nanostructured materials: nanocrystals, nanoparticles, oxide nanostructures, nanotubes and nanowires. Characterization of nanoparticles: transmission electron microscopy(TEM), atomic forcemicroscopy(AFM), X-ray spectroscopy.

Module IV: Shape of nanoparticles

Exterior surface and particle shape, interior nanoscale surfacearea, specific surface area, spherical cluster approximation, packing fractions and density,structural magic numbers.Nanooptics: interaction of light with nanoparticles, surface Plasmon resonance, colourgeneration from nanoparticles, quantum dots,Determination of nanoparticle size, surface area and porosity-BET method, BJH method,Mercury Porosimeter method.

References

1. *H.S. Nalwa, R. Smalley, Encyclopedia of Nanoscience and Technology, American Scientific Pub., 2004.*
2. *C.N. R. Rao, A. Govindraj, Nanotubes and Nanowires, 2nd Edn., RSC, 2011.*
3. *C.N.R. Rao, A. Muller, A.K. Cheetham, The Chemistry of Nanomaterials, Vol 1 & 2, John Wiley & Sons, 2005.*
4. *G. Schmid, Nanoparticles: From Theory to Applications, John Wiley & Sons, 2011.*
5. *G.L. Hornyak , H.F. Tibbals , et.al. Introduction to Nanoscience & Nanotechnology, CRC Press, 2009.*

IMSE606ES-2 Natural hazards& Introduction to Disaster Management

Credits 2(2-0-0)

Module I: Introduction

Definition of hazard; natural, technological, and context hazards; concept of risk and vulnerability; reasons of vulnerability - rapid population growth, urban expansion, environmental pollution, epidemics, industrial accidents, Disaster Management cycle

Module II: Natural hazards

Natural hazards: hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter; volcanoes: causes of volcanism, geographic distribution; floods: types and nature, frequency of flooding; landslides: causes and types of landslides, landslide analysis; drought: types of drought - meteorological, agricultural, hydrological, and famine; Glacial Lake Outburst Floods (GLOF); tornadoes, cyclone &hurricanes; tsunamis: causes and location of tsunamis; coastal erosion, sea level changes and its impact on coastal areas and coastal zone management.

References

1. Coppola D. P. 2007. Introduction to International Disaster Management. Butterworth Heinemann.
2. Cutter, S.L. 2012. Hazards Vulnerability and Environmental Justice. EarthScan, Routledge Press.
3. Keller, E. A. 1996. Introduction to Environmental Geology. Prentice Hall, Upper Saddle River, New Jersey.
4. Pine, J.C. 2009. Natural Hazards Analysis: Reducing Impact of Disasters. CRC Press, Taylor & Francis Group.
5. Schneid, T.D. & Collins, L. 2001. Disaster Management and Preparedness. Lewis Publishers, New

IMSE606ES-3 Remote sensing and GIS

Credits 2(2-0-0)

Module I: Remote Sensing:

definitions and principles; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation.

ModuleII: Geographical Information Systems

definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system; land use/ land cover mapping; overview of GIS software packages; GPS survey, data import, processing, and mapping.

Module III: Applications

Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies.

References

1. Zar, J.H. 2010. Biostatistical Analysis (5th edition). Prentice Hall Publications.
2. Edmondson, A. &Druce, D.1996.Advanced Biology Statistics. Oxford University Press.
3. Demers, M.N. 2005. Fundamentals of Geographic Information System. Wiley & Sons.
4. Richards, J. A. &Jia, X. 1999. Remote Sensing and Digital Image Processing. Springer.
5. Sabins, F. F. 1996. Remote Sensing: Principles an Interpretation. W. H. Freeman.

Second Language Elective Courses

IMSE304LM Malayalam-1

Credit 2 (2-1-0)

അനുഭവാഖ്യാനങ്ങൾ

കഥ, കവിത, നോവൽഎന്നീസാഹിത്യജനുസ്സുകൾപോലെതന്നെ പ്രസക്തമാണ്ആത്മകഥ, ജീവചരിത്രം, യാത്രാവിവരണം, സ്മരണതുടങ്ങിയവയും. ഇവഒരേസമയംസാഹിത്യവുംചരിത്രവുമാകുന്നു. സാഹിത്യം എന്ന വ്യവഹാരത്തെത്തന്നെ നിരന്തരം പുതുക്കിഷ്പണിയുന്ന ഏതാനും അനുഭവാഖ്യാനങ്ങളുടെവായനയുംവിശകലനവുമാണ് ഈ കോഴ്സിലൂടെലക്ഷ്യമിടുന്നത്.

മൊഡ്യൂൾ 1: ആത്മകഥ, ജീവചരിത്രം

വിശദപഠനത്തിന്:

1. *ക ൽക്കാടുകൾക്കിടയിൽഎന്റെജീവിതം* (കല്ലേൻ പൊക്കുടൻ)
2. *മഞ്ജുതരം* (കലാമണ്ഡലംഹൈദരലി)
3. അക്കമ്മ ചെറിയാൻ (ആർ. പാർവതിദേവി)

മൊഡ്യൂൾ 2: യാത്രാവിവരണം

വിശദപഠനത്തിന്:

1. *ബംബംഹരഹര ബംബംബോൽ* (സക്കറിയ)
2. *നീളയുടെതീരങ്ങളിലൂടെ* (ആലങ്കോട് ലീലാകൃഷ്ണൻ)

മൊഡ്യൂൾ 3: സ്മരണ, സമീക്ഷ

1. 'മഹാനടൻ'
   (ബാലചന്ദ്രൻ ചുള്ളിക്കാട്, *ചിദംബരസ്മരണകൾ*)
2. 'ചെമ്പരത്തിപ്പൂവായി വിരിഞ്ഞുംതുടുത്തുംകൊഴിഞ്ഞും'
   (ഇ.പി. രാജഗോപാലൻ, *ദേശാഭിമാനി*ഓണപതിപ്പ്, 2019)

റഫറൻസ്

1. കെ.എം. ജോർജ്ജ്, *ജീവചരിത്രസാഹിത്യം*, 1982, നാഷണൽ ബുക്ക്സ്റ്റാൾ, കോട്ടയം.
2. കെ.എം. ജോർജ്ജ് എഡി., *ആധുനികസാഹിത്യചരിത്രം പ്രസ്ഥാനങ്ങളിലൂടെ*, 2009, ഡി.സി. ബുക്സ്, കോട്ടയം.
3. ജി. കുമാരപിള്ള, 'ജീവചരിത്രസാഹിത്യം: തത്ത്വവിചാരം', *പി.കെ.പരമേശ്വരൻ നായരുംജീവചരിത്രസാഹിത്യവും*, പന്മന രാമചന്ദ്രൻ നായർ (എഡി.), 1992, പി.കെ.പരമേശ്വരൻ നായർ മെമ്മോറിയൽ ട്രസ്റ്റ്, തിരുവനന്തപുരം.
4. നടുവട്ടംഗോപാലകൃഷ്ണൻ, *ആത്മകഥാസാഹിത്യം മലയാളത്തിൽ*,1985.

IMSE404LM Malayalam-2

Credit 2 (2-1-0)

സാഹിത്യപഠനം

മൊഡ്യൂൾ 1: കവിതാസാഹിത്യം

വിശദപഠനത്തിന്:

1. അധ്യാത്മരാമായണംകിളിപ്പാട്ട് (ലക്ഷ്മണോപദേശം)
2. വീണപൂവ് (കുമാരനാശാൻ)
3. കുറ്റിപ്പുറം പാലം (ഇടശ്ശേരി)
4. കൊച്ചിയിലെ വൃക്ഷങ്ങൾ (കെ.ജി.ശങ്കരപ്പിള്ള)
5. മുറ്റമടിക്കുമ്പോൾ (അനിത തമ്പി)

മൊഡ്യൂൾ 2:നോവൽ, ചെറുകഥ

വിശദപഠനത്തിന്:

1. *മഞ്ഞ്* (എം.ടി.വാസുദേവൻ നായർ)
2. *ആടുജീവിതം* (ബെന്യാമിൻ)
3. 'ഭൂമിയുടെആവകാശികൾ' (വൈക്കം മുഹമ്മദ് ബഷീർ)
4. 'ഭ്രാന്ത്' (സി. അയ്യപ്പൻ)
5. 'അഗ്നി' (സിതാരഎസ്.)
6. 'ഓർമ്മച്ചിപ്പ്' (കെ.വി. പ്രവീൺ)
7. 'ശരീരദൂരം' (കെ.പി. രാമനുണ്ണി)

മൊഡ്യൂൾ 3: നിരൂപണം

വിശദപഠനത്തിന്:

1. 'കാളിദാസനുംകാലത്തിന്റെ ദാസൻ' (ജോസഫ്മു ശേരി)
2. 'നമ്മുടെ അടുക്കളകൾ തിരിച്ചുപിടിക്കുക' (സാറാജോസഫ്)
3. 'ഭാഷ, നവോത്ഥാനം, ജനാധിപത്യം' (പി. പവിത്രൻ)

റഫറൻസ്

1. *കവിതാസാഹിത്യചരിത്രം*(എം.ലീലാവതി)
2. *ആധുനികമലയാളകവിത* (എൻ. അജയകുമാർ)
3. *മലയാളകവിതാപഠനങ്ങൾ* (സച്ചിദാനന്ദൻ)
4. *നോവൽസാഹിത്യചരിത്രം* (കെ.എം.തരകൻ)
5. *ആധുനികതയുടെ മധ്യാഹ്നം*(ആർ. നരേന്ദ്രപ്രസാദ്)
6. *ചെറുകഥ: ഇന്നലെ, ഇന്ന്*(എം.അച്യുതൻ)
7. *ചെറുകഥാപ്രസ്ഥാനം* (എം.പി. പോൾ)
8. *ചെറുകഥ - വാക്കുംവഴിയും* (കെ.എസ്. രവികുമാർ)
9. *മലയാളസാഹിത്യവിമർശനം* (സുകുമാർഅഴീക്കോട്)
10. *മാതൃഭാഷയ്ക്കുവേ ിയുള്ളസമരം*(പി. പവിത്രൻ)

IMSE304LH Hindi-1

Credit 2 (2-1-0)

गद्य और एकांकी(Prose & One-Act Plays)

गद्य/Prose

1. कफ़न चोर का बेटा – उषा बाला
2. जब मैं फेल हुआ – ए. पी. जे. अब्दुल कलाम
3. जब इंतिज़ार हुसैन अपनी जन्मभूमि आये – अज़गर वजाहत

एकांकी / One -Act plays

1. दीपदान – रामकुमार वर्मा
2. जान से प्यारे – ममता कालिया
3. बहु की विदा – विनोद रस्तोगी

(Module -wise Distribution)

Module I	Module II	Module III
कफ़न चोर का बेटा	जब मैं फेल हुआ	जब इन्तिज़ार हुसैन अपनी जन्मभूमि आये
दीपदान	जान से प्यारे	बहू की विदा

Text Book–**साहित्य दर्पण**

IMSE404LH Hindi-2

Credit 2 (2-1-0)

कविता और व्याकरण(Poetry & Grammar)

कविता(Poetry)

1. कबीरदास – दोहा (2)
2. तुलसीदास – पद (2)
3. जागो फिर एक बार – सूर्यकांत त्रिपाठी निराला
4. छीनने आए हैं वे – सर्वेश्वरदयाल सक्सेना
5. सबूत – अरुण कमल
6. जंगल के उजाड़ में – विनोद कुमार शुक्ल
7. बाज़ार – मंगलेश डबराल
8. बीसवीं शती के अंतिम दिनों का आश्चर्य – राजेश जोशी
9. ठंठे पानी की मशीन – एकांत श्रीवास्तव
10. अच्छे आदमी – कुमार अम्बुज

व्याकरण(Grammar)

1. सामान्य हिंदी व्याकरण तथा रचना – श्रीकृष्ण पाण्डेय (Page19-58)
   शब्द विचार – संज्ञा – लिंग – वचन – कारक – सर्वनाम – विशेषण – क्रिया – क्रिया के रूपांतर - काल

(Module -wise Distribution)

Module I	Module II	Module III
1. कबीरदास 2. तुलसीदास 3. जागो फिर एक बार	4. छीनने आए हैं वे 5. सबूत 6. जंगल के उजाड़ में	7. बाज़ार 8. बीसवीं शती के अंतिम दिनों का आश्चर्य 9. ठंठे पानी की मशीन 10. अच्छे आदमी
व्याकरण शब्द विचार संज्ञा लिंग	व्याकरण वचन कारक सर्वनाम	व्याकरण विशेषण क्रिया क्रिया के रूपांतर - काल

Text Book–**काव्य कुसुम, सामान्य हिंदी व्याकरण तथा रचना**

IMSE304LS Sanskrit-1

Credit 2 (2-1-0)

Fundamentals of Sanskrit Language & Poetry

Module I:
The nature of Sanskrit Language – alphabets, vocabulary and sentence.
Provide chance to the students to find out as many words as they could collect. Vibhaktis of Rama, Hari, Guru, Pitr, Sita and Verbal forms of Dhatus Path, Bhu and Edh – Lat forms.
Translation exercises to comprehend the sentence structure of Sanskrit.

Module II: Introduction to Sanskrit Literature. Kalidasa and his works.

Textual Study – Raghuvamsha – 5th Canto – first 35 Slokas

IMSE404LS Sanskrit-2

Credit 2 (2-1-0)

Scientific Literature in Sanskrit

Module I: Introduction to Scientific thoughts in Ancient India – Vedas and Darsanas.

Module II: Metaphysics in Ancient Philosophies in India – Textual Study.

Prescribed Text : Tharkasangraha – up to the end of the text

IMSE304LA Arabic-1

Credit 2 (2-1-0)

Introductory Arabic

Module I

1-In the college
2-The traveller
3-The picture
4-The lunch is ready

Module II

5- Where do you live?
6- I am younger child in the family
7- I am sure
8-I am a student

Module III

9-The street is crowded
10-What is your opinion?
11-What is your Hobby?
12-How to make friends?

Module IV

13-Why were you absent?
14-What do you prefer?
15-I wake up early
16-How many periods do you study in a day?

Module V

17-did you take medicine?
18-What is the reason?
19-A sad news
20-Now I am a grown up man

Prescribed Text Book:
Muhadasath Youmiyya, by: Dr Mohammed Haneefa. P, Al Huda book stall, Calicut

Reading list:

1. *Arabic by Radio, Part 1, Cairo.*
2. *Teach yourself Arabic, Ali, Sayed, Khazi Publishers, New Delhi.*
3. *Arabic for beginners, Siddiqui, Abdul Hamid (2005), Islamic Book Service.*
4. *Introducing Arabic, Michael Humisa (2004), Good word books, New Delhi*
5. *Arabic for various situations, Abdul hameed V P and Abdul Haleem N K, Al huda Book Stall Calicut*

MSE404LA Arabic-2

Arabic Communication

Credit 2 (2-1-0)

Module I

1-You are wanted
2-The library
3-The Workshop
4-The Playground and The Restaurant
5- Competition

Module II

6- Examination
7- A Trip
8- New Friend
9- In the library
10-journalist

Module III

11- The Bank
12- The Hotel
13- The Timing
14- The Holiday
15- Pharmacy

Module IV

16-Garments
17-Money Exchange
18-Railway station
19- The customs
20-The Doctor

Module V (Correspondence)

21-Personal Data
22-Call letter
23-Greeting Letter
24-Application for Leave
25-Application for Job

Prescribed Text Book*:*

Muwaasalaat wa Murasalaat, by: Dr. Muhammad Haneefa. P, Al Huda book stall, Calicut

Reading list:

1. *Functional Arabic by: Dr.Veeran Mohiyideen, published by: Arab Net, Calicut.*
2. *Business Arabic ,Rahmathulla A.I, Calicut*
3. *An Easy Way to Commercial and Journalistic Arabic ,Muhammed Ismail al Mujaddidi,Sahara publications,Calicut*
4. *A Hand book of Commercial Arabic, Dr.K.P.Aboo backer. Published by: Al Huda Book stall, Calicut.*
5. *Arabic Composition and Translation, Dr.N.Abdul Jabbar, published by: Al Huda book stall, Calicut.*
6. *Journalistic Arabic, by: VP Abdul Hameed &N.K.Abdul Haleem, Published by: Al Huda Book stall, Calicut*
7. *Essential Arabic, by: Rafiul Imad Fayn*

IMSE304LF French-1

Credit 2 (2-1-0)

LE FRANÇAIS ÉLEMENTAIRE (FUNDAMENTALS OF FRENCH LANGUAGE)

Course Overview and Context:
It focuses on basic sound patterns of the French language and rudiments of French grammar.

Module I :

Bienvenue – Qui est-ce ? Les alphabets – Les sons – les accents - saluer-se présenter quelqu'un - faire connaissance avec quelqu'un –les nombres – les verbes être, s'appeler – l'article défini

Module II:

Ça va bien ? – correspond@nce.com Les verbes aller et avoir – l'adjectif possessif au singulier – l'article indéfini – la politesse – demander des nouvelles d'une personne – chercher un(e) correspondant(e)

Module III :

Trouvez l'objet – Portrait-robot Nommer, monter et situer des objets – exprimer la possession – indiquer les couleurs – les pronoms toniques – le pluriel des articles, des verbes, des adjectifs possessifs, la négation

Module IV:

Shopping – Le coin des artistes Caractériser un objet – faire des achats - exprimer des goûts – l'adjectif interrogatif – les adjectifs interrogatifs – l'interrogation – comprendre un texte court

Module V:

Appartement à louer – C'est par où ? Situer un lieu sur un plan – décrire un appartement – indiquer une direction – indiquer un moyen de transport – les prépositions – l'impératif – l'adverbe y – comprendre une annonce immobilière – présenter des informations touristiques

Learning Resources(Textbook)
Guy Capelle, Robert Menand : Le Nouveau Taxi 1, Hachette Livre 2009, Lessons 1-10, (Pp 13-37)

IMSE404LF French-2

Credit 2 (2-1-0)

LE FRANÇAIS INTERMEDIAIRE (INTERMEDIATE FRENCH)

Aim of the course: It aims at increasing the students' linguistic competency which would enable them to apply the grammatical structures correctly to create original sentences.

Competencies of the course:

- To write a post card
- To talk about one's day, daily activities
- Understand and use familiar everyday expressions
- Develop vocabulary and grammar skills
- Describeone'simmediateenvironment

Course Overview and Context: This module is comprised of an in-depth study of grammar categories and structures with practice drills to enable the students to use it more confidently.

Module I:

Bon Voyage – Marseille Donner un conseil – décrire un lieu – C'est + lieu – les prépositions de lieu – on – les moyens de transport – localisation – comprendre et présenter des informations touristiques

Module II:

Un aller simple – À Londres Demander et donner l'heure – indiquer une date – demander poliment – situer dans le temps – les verbes partir, faire au présent – les professions – réserver un billet de train – s'informer sur les activités des autres

Module III :

Le dimanche matin – Un journée avec Laure Manaudou S'informer sur une activité en cours, habituelle – dire quel sport on fait – parler des activités quotidiennes les verbes lire et écrire au présent – le genre des noms - les verbes pronominaux – faire de, jouer à + sport – comprendre un article de journal simple

Module IV:

On fait des crêpes ? – Il est comment ? Demander et exprimer des besoins – s'informer sur des habitudes – indiquer des quantités – les articles partitifs – rapporter des événements passés – exprimer une opinion – le passé composé avec avoir – la formation du participe passé – parler des ses habitudes alimentaires – parler de sa journée

Module V :

Chère Léa… - Les fêtes Interroger sur le moment et la durée – comprendre des souvenirs – le passé composé avec être – pour et dans + durée future – écrire une carte postale – évoquer des fêtes traditionnelles

Learning Resources (Textbook)

Guy Capelle, Robert Menand : Le Nouveau Taxi 1, Hachette Livre 2009, Lessons 1-10, (Pp 38-64)

General Elective courses (Semester IV)

IMSE405GE-1 Principles of Management

Credit 2 (2-1-0)

Module I: Evolution of Management, Management-Meaning, Nature & Significance-Combination of Art & Science, Management as a Profession, Management Vs Administration, Levels of Management-Elements of managerial processes-Styles & Roles of Managers in Organizations. Contributions of Taylor and Fayol, Human Relations & Behavioural Schools-Hawthorne Studies.

Module II: .Planning-Nature, Process of Planning, Planning and Environmental Uncertainties, Types of Planning, Advantages and Limitations of Planning-Decision Making-Stages in Decision Making.

ModuleIII: Nature & Significance of Organization, Authority & Responsibility Relationships-Span of Control, Process of Delegations-Barriers to Delegation, Centralization & Decentralization. Concept of Line & Staff-Overcoming Line-staff conflict, Committees, Co ordination, Organization Structures, Types, Advantages & Disadvantages.

Module IV: Staffing, Motivation & Leadership. Scope of Staffing Functions, Theories of Motivation. Theory X, Theory Y, Theory Z. Maslows need hierarchy. Leadership Styles.

Module V: Communications of Control, Process of Communication. Verbal & Non Verbal, Barriers to communication, Types, Process, Tools of control, Characteristics of Effective Control System, Human Reaction to control system.

References:

1. *Drucker, F. Peter - Management-Tasks, Responsibilities & Practices.*
2. *Koontz "O" Donnel Weihrich - Elements of Management.*
3. *Koontz H, "O" Donnel C - Management-A Book of Reading.*
4. *Drucker, F. Peter - The Practice of Management.*
5. *Terry and Franklin - Principles of Management*
6. *Stoner - Principles of Management*
7. *L. M. Prasad; Principles of Management; Sultan Chand and Sons, 6th Edition*

IMSE405GE-2 Disability and Rehabilitation

Credit 2 (2-1-0)

Module I: Health, Disease, Disability
Definition of health, WHO definition, dimensions of health-Physical dimension, mental dimension, social dimension, emotional dimension, concept of disease, causes of disease, levels of prevention, screening tools for assessing disability.

Module II: Disability spectrum
Concept of impairment, disability, handicap,Prevalence of disability in India, motor disability, sensory disability, cognitive, neurological and emotional disorders. Role of non-governmental agencies in the area of disability.

Module III: Epidemiology of disability
Magnitude of problem, equality of life, incidence and prevalence of various disability, Etiology of disability, natal, pre-natal, prenatal, low birth weight,birth asphyxia, birth injuries.

Module IV: Early detection and assessment of disabilities
Assessment of physical growth, developmental assessment, early detection of hearing abnormalities,vision abnormalities, neurological abnormalities.

Module V: Guidance and counselling
Principles and process of counselling-crisis intervention,parenting skills for the children with disabilities.

Module VI: Rehabilitation
Basic concept: Concept and definition of impairment, disability, handicapped, habitation and rehabilitation, Principles of rehabilitation, types of rehabilitation-institution based, home based, community based rehabilitation.

Module VII: Vocational rehabilitation
Approaches and agencies of vocational rehabilitation, community based rehabilitation (CBR),Social and educational rehabilitation of hearing and speech impaired, visually impaired, intellectually challenged and multiple disabled, learning disability groups.

References

1. *Kieman,W, Stark J(1986) Pathways to employment for adults with developmental disabilities Battimore:Pau H Brookes*
2. *McCathy,(1989) Rehabilitation Audiology-Children and adults. CroomHellen, London*
3. *Chauhan,S.S Education of Exceptional Children, Indian Publishing Co.*
4. *Wecg, M(1990) Special Education Research and Practice, AdotallPorganan Press, New York*
5. *Schow, R.L &Nerbonne, M.A(1989). Introduction t Aneal Rehabilitation, library of Cogrers-catalog-in publication Data,USA*
6. *Nacasimham,M.C and Mukherji, A.K (1987) Disability a continuing challenge. Willey Eastern Ltd. Hyderabad.*

- **IMSE405GE-3 Understanding Social Justice** (2 Credits)
- **IMSE405GE-4 Constitutionalism, Legality and Justice in India** (2 Credits)
- **IMSE405GE-5 Public Health and Global Governance** (2 Credits)