MANIPAL UNIVERSITY

International Centre for Applied Sciences

(A constituent Institute of Manipal University, India)

B. Sc. (APPLIED SCIENCES)

A Bachelors Degree Programme under the Manipal University

ACADEMIC REGULATIONS, COURSE STRUCTURE AND SYLLABUS OF FIRST TO SIXTH SEMESTER

(2017 - 2020)

Applicable for the 2017 Admission Batch

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BACHELOR OF SCIENCE PROGRAMME IN ENGINEERING
RULES & REGULATIONS

1. INTERNATIONAL TRANSFER PROGRAM (ITP) IN ENGINEERING:

International Centre for Applied Sciences (ICAS), Manipal; affiliated to Manipal University is offering a full time (three years), B.Sc.(Applied Sciences) Degree program **with a provision for credit transfer to any of the foreign universities at the end of second year of studies.**

It is a unique program where the students usually spend the first two years in ICAS, Manipal University and the following two years in a university abroad, of their choice (the full time, international engineering degree awarded by the foreign university only). The credit transfer will depend upon the academic policy of the respective foreign universities and can be up to 100%. This is made possible by adopting the high quality curriculum, teaching and evaluation methodologies that are followed by top universities abroad.

Since 1994, about 1600 students have entered more than 100 foreign universities (spread across USA, UK, Australia, Germany, France, Canada & the like countries) through acceptable credit transfer from ICAS, pursuing their Bachelor/Master Degree in Applied Sciences/Engineering.

The following streams are offered at ICAS under the International Transfer Program:

- Aeronautical/Aerospace/Aviation
- Architecture
- Biomedical
- Biological
- Chemical
- Civil
- Computer Science
- Electrical & Electronics
- Mechanical
- Mechatronics

Students opting for Aerospace/Aviation/Aeronautical and Architecture streams only can take credit transfer after the first year. All other students are required to complete two years of study at ICAS before getting their credits transferred to foreign universities. The academic year at ICAS is divided into two Semesters. Each Semester is of 12/14 weeks teaching duration. During the first semester, the students of all the branches (except Architecture) study common subjects. Adequate importance is given to English Communication, Basic Sciences and Humanities during the entire period of two years at ICAS, as required by the foreign Universities.

2. CREDIT TRANSFER FLEXIBILITY:

Students can switch over from the above mentioned core streams to any of the allied streams/specializations at the university abroad, during credit transfer. For example, the students who studied at ICAS in the stream Computer Science can continue in the same discipline or can switch over to Computer Engineering or Information Science or related fields. Similarly, from Electrical & Electronics stream to core Electrical Engineering or Electronics & Communication specializations and from Mechanical to core Mechanical or Automobile or Production/Manufacturing/Industrial Engineering streams at the foreign university.

3. ELIGIBILITY FOR ADMISSION

Pass in 10+2 (CBSE, ICSE, “A” level, IB, HSC, OSSD, American High School Diploma or Equivalent Examination) with a minimum of 60% (aggregate) or ‘C’ grade in English, Physics and Mathematics with Chemistry or Biology or Computer Science or Biotechnology or

Electronics as optional subjects in the 12th standard. Students seeking admission to Architecture need to have a minimum score of 80 out of 200 in NATA examination.

4. ACADEMIC CALENDAR

The academic calendar will be prepared by ICAS in line with the academic calendar of Manipal University (MU) before the commencement of the classes for both Odd Semester and Even Semester of the Academic Year, containing the dates for:

- Commencement of the classes
- Internal Assessment tests and Student Feedback
- Last instructional day
- Start and End dates for the end semester examination
- Result declaration date
- Date for paper seeing & revaluation
- Date of declaration of revaluation results
- General Holidays and Co-curricular & Extra-curricular Events

5. ACADEMIC/EXAMINATION REGULATIONS

A) 75% attendance is compulsory to the classes of any subject under any circumstances. If a student is unable to satisfy this minimum attendance requirement he/she will not be permitted to attend the end semester examination of that subject and will get detained, as per the institute attendance regulations.

B) A student has to re-register for those subjects in which he/she was not allowed to write the end-semester examination due to shortage of attendance (less than 75% of the classes conducted for the subject). The institute will conduct special classes (crash course) in the evening (after regular teaching hours) for such re-registered students. The re-registered student has to attend internal assessment tests (which are conducted exclusively for them) and must fulfill the minimum attendance regulation (75%) to be eligible to write the End Semester Examination. No condoning of attendance for any reason is permitted during such crash courses.

C) Any student desirous of improving internal assessment marks in the subject(s) of the previous semesters has to reject the particular subject(s) of that semester/year and has to re-appear for the IA tests/submit assignments and write the end-semester exam. along with the regular students of that particular semester/year (Odd in Odd and Even in Even semesters, respectively) by paying the prescribed fees. Such a student cannot claim to revert to the old IA marks/end exam. marks if the new marks are lower than those of the former attempt.

D) The maximum duration for a student for passing/re-appearing in any subject offered, is twice the duration of the academic programme from the date of joining. This applies also to the students who discontinue the academic programme for any reason and rejoins the programme at a later date.

E) After the expiry of the above validity period, the student may get admitted afresh to the programme and repeat all semesters from the beginning. In such cases, the student will be governed by the rules, regulations, courses of study and syllabi in force at the time of re-admission.

F) Change of branch is allowed on prior written request, against vacancies, before the commencement of the second semester, based on the academic performance in the first semester at ICAS.

5.1 Internal Assessment

- A total weightage of 50 marks is reserved for internal assessment.
- Two internal tests, each of 20 marks, are conducted for all the courses registered in a semester.
- First test will be conducted after five weeks of the commencement of the program and the second test will be conducted after ten weeks of the commencement of the program.
- Ten marks are reserved for two assignments to be given during the program (each assignment carries five marks). The assignments will be given between the first test and the end semester examination.
- If a student is unable to attend any one of the tests because of ill health or other genuine reasons or is desirous of improving his IA marks, a make-up test may be given after the second test.

5.2 End Semester Assessment

- The maximum marks for the theory examination are100. Out of this, 50marks are for the Internal Assessment and 50 for the end-semester examination. However, End semester assessment will be conducted for 100 marks and then scaled down to 50.
- The minimum marks for passing a subject is 50% when the end-semester theory (or practical) & the Internal Assessment marks are put together, with a minimum of 35% marks to be scored in each subject (theory:18/practical:09), in the end semester examination.
- The student performance in laboratory courses is evaluated out of a maximum of 50 marks. It is based on in-semester assessment of 25 marks (reflecting the performance of the student in the conduct of the experiment, regularity and timely submissions) and end-semester lab. examination component (internal) of 25 marks. Completing all the prescribed experiments and attending the lab. examination at the end of the semester on the specified date & time, is mandatory. No change of date & time for the lab. examination is permitted, once notified.

5.3 Duration of the Examination & Tests

The end semester examination will be of three hours duration and the internal assessment tests will be of one hour duration each.

6. GRADING, RESULT AND ISSUE OF GRADE CARDS

6.1 ICAS shall follow FOUR POINT fixed grading system which is as follows:

Letter Grading System:

Letter Grade	Percent Equivalent Marks	Grade Value
A (Outstanding)	100 – 90	**4.0**
B+ (Very Good)	89 – 80	**3.5**
B (Good)	79 – 70	**3.0**
C+ (Above Average)	69 – 60	**2.5**
C (Average)	59 – 50	**2.0**
F (Fails)	Below 50	**0.0**

Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA):
Each course grade is converted into a specific number of points associated with the grade. These points are weighted in accordance with the number of credits assigned to a course.

The weighted average of GPAs of all semesters that the student has completed at any point of time is the Cumulative Grade Point Average (CGPA) at that point of time. CGPA is updated after every semester the student completes.

Calculation of GPA and CGPA:
Example:

Subjects	Credits	Letter Grade	Grade Value	Credit x Value	Grade Points
MATHS	4	C+	2.5	4x2.5	10
PHYSICS	3	C	2	3x2	6
CHEMISTRY	3	B+	3.5	3x3.5	10.5
EG – I	4	B	3	4x3	12
TOTAL	14				38.5

In this case, GPA = $\frac{\text{total grade points}}{\text{total credits}}$

$= \frac{38.5}{14} = 2.75$

Suppose the GPA in four consecutive semesters are 3.0, 2.91, 2.80 and 3.95 with 22, 22, 18 and 19 respective course credits, then the
CGPA = (3.0x22+2.91x22+2.80×18+3.95×19) / (22+22+18+19) = 3.15

Generally:

$$GPA = \frac{\sum_{i=1}^{n} Ci\,Gi}{\sum_{i=1}^{n} Ci} \quad \text{and} \quad CGPA = \frac{\sum_{j=1}^{N} GPAj \times (\Sigma Ci)j}{\sum_{j=1}^{N} (\Sigma Ci)j}$$

where n = number of courses
Ci = course credit
N = number of semesters
Gi = corresponding grade value

6.2 Results are declared by Director (ICAS) along with Examination Coordinator (ICAS) and a copy of same is sent to MU, Manipal.

6.3 Examination Coordinator (ICAS) shall also coordinate the revaluation process and declare the revaluation results.

6.4 Grade Cards are prepared and printed by MU Manipal and signed by Registrar (Evaluation) of MU and Director (ICAS).

6.5 Consolidated marks cards: If a candidate has taken more than one attempt to pass in all the subjects of a semester examination, he/she can apply for consolidated marks card of the semester from MU. In this marks card, only the marks of the passed attempts are shown along with the month and the year of passing the subjects.

7. APPEAL PROCESS

7.1 In all theory subjects, students are allowed to request for paper seeing and revaluation by paying the prescribed fee. However the marks scored in the revaluation of such theory subjects will be final and a binding on the student.

7.2 Examination Coordinator (ICAS) will be coordinating this activity.

7.3 Scripts and scheme of evaluation are made available at the time of paper seeing.

7.4 ICAS will assign a different examiner for revaluation, as far as possible.

7.5 Fees will be refunded in case of Grade improvement.

8. STUDENT ATTENDANCE REGULATIONS - 2016

All the students are expected to attend all the classes in each subject. However, it is mandatory for a student to have a minimum of 75% attendance in individual subjects, for being eligible to write the end-semester examination, in compliance with the Manipal University Norms. In case of Laboratory classes, completing all the experiments is a pre-requisite for in-semester assessment.

The above 25% condoning of the attendance takes care of his/her absence due to any medical/personal reasons/purposes including writing eligibility exams, attending passport/visa related works, emergency & hospitalization cases etc. and there is no question of considering any medical certificate when a student has deficiency of attendance beyond 25%. Students are advised to take eligibility exams. like TOEFL/IELTS/SAT during vacation period only.

Generally, the above 25% condoning of the attendance includes his/her absence in the class on account of representing the institute/university in the co-curricular/extra-curricular activities also. However, as an encouragement to the students involving in such activities, further condoning of attendance up to a maximum limit of 10% of the total classes held in the individual course in that semester may be permitted (not applicable to crash courses), subject to the following conditions:

(1) The desirous student must apply for the same and obtain prior permission (in writing, in the forms available in ICAS Office) from the Associate Director, without which no request for condoning of attendance will be entertained.
(2) The student has to obtain authentication/endorsement in the same form, from the concerned authorities (listed below) authenticating his/her participation in the said activity and has to produce it at the ICAS office strictly within two weeks after the event. No letter received after this duration will be entertained for condoning of attendance.
(3) Associate Director will further instruct the concerned teachers handling the course to consider such cases for condoning of attendance, subject to a maximum ceiling of 10% of the total classes held in that course.

Sl. No.	Nature of Event	Authority for Endorsement
01	Representing Inter-Institute / Inter-University Sports activity	Director of Physical Education, (MIT)
02	Representing Inter-Institute / Inter-University Cultural activity / competitions	Faculty Coordinator, Student Activities, ICAS / Deputy Director, Student Affairs, MU
03	Presenting papers in Conferences / Tech. Fests / Research Colloquiums etc.	Faculty Coordinator, Student Counseling, ICAS
04	Writing Eligibility Exams like TOEFL/IELTS etc. and attending Passport/Visa related activities (only in exceptional cases, only for the days of exam/meeting, with proof)	Associate Director, ICAS

Students are advised to check their attendance position regularly from the respective teachers and try to make up for the attendance shortage, if any by attending all the remaining classes. Branch Faculty Coordinators / Subject Teachers shall display the student attendance position along with IA test marks, a week after the first & second tests respectively, monitor the attendance position of irregular students and initiate appropriate remedial steps. The above Attendance Regulation is applicable to all ICAS students, with effect from 01 June 2016.

9. TEACHER GUARDIANSHIP (TG) and FACULTY ADVISER (FA) SCHEMES

In order to monitor the progress of the students and supervise their welfare ICAS has arranged teacher guardianship scheme. A batch of 10 students will be allotted to a teacher who will act as a friend, philosopher and guide to these students. The TGs will be in touch with the parents/guardians of the students to inform them the welfare of these students.

In the second year 20 - 25 students are allotted to each faculty handling respective branch classes and will act as Faculty Adviser (FA). The role of FA is almost same as TG, but in addition they advise, guide and lead them towards their future academic plans in their respective chosen branches.

The parents/guardians are also advised to keep in touch with the TGs/FAs of their children/wards.

The Associate Director of ICAS along with the Faculty Coordinator of Student Welfare will monitor these schemes and will counsel the students from time to time.

COURSE STRUCTURE
B.Sc. (BIOLOGICAL)

FIRST YEAR - I SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 111	MATHEMATICS –I	3–1-0–4
IPH 111	PHYSICS- I	3–0-0–3
ICE 111	MECHANICS OF SOLIDS	3–1-0–4
ICS 111	PROBLEM SOLVING USING COMPUTERS	3–1-3–5
IHS 111	A COURSE ON PSYCHOLOGY FOR ENGINEERS	3–0-0–3
IHS 112	COMMUNICATION SKILLS IN ENGLISH	3–0-0–3
IME 111	ENGINEERING GRAPHICS - I	0–0-3–1
		18–3-6-23

SECOND SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 121	MATHEMATICS – II	3–1-0–4
IPH 121	PHYSICS – II	3–0-3–4
ICH 121	CHEMISTRY	3–0-3–4
IME 121	ENGINEERING GRAPHICS - II	0–0-3–1
IBT 121	BIOPROCESS CALCULATIONS	3–1-0–4
IBT 122	BIOLOGY	3–1-0–4
		15–3–9-21

SECOND YEAR - THIRD SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 231	MATHEMATICS – III	3–1-0–4
IBT 231	BIO-CHEMISTRY	3–0-3–4
IBT 232	MICROBIOLOGY	3–0-6–5
IBT 233	INSTRUMENTATION AND MEASUREMENT FOR BIOLOGICALS	3–0-0–3
IBT 234	TRANSPORT PROCESS I (FLUID FLOW)	3–1-0–4
IBT 235	CELL MOLECULAR BIOLOGY	3–0-0–3
		18-2-9–23

FOURTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IHS 241	ENGINEERING ECONOMICS & MANAGEMENT	3–1–0–4
IBT 241	TRANSPORT PROCESS II (HEAT-MASS TRANSFER)	3–1–0–4
IBT 242	BIO-ORGANIC CHEMISTRY	3–0–0–3
IBT 243	FOUNDATIONS OF COMPUTATIONAL BIOLOGY	3–0–6–5
IBT 244	GENETIC ENGINEERING	3–0–3–4
IBT 245	BIOLOGICAL THERMODYNAMICS	3–0–0–3
		18–2–9–23

THIRD YEAR - FIFTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IBT 351	PROJECT WORK	0–0-36–12
		0-0- 36–12

SIXTH SEMESTER

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL/LAB./ CREDITS
IBT 361	BIOPROCESS ENGINEERING		3–1-0–4
IBT 362	SEPARATION TECHNIQUES IN BIOTECHNOLOGY		4–0-3–5
IBT 363	ELECTIVE - I	GENOMICS AND PROTEOMICS	3–0-0–3
		BIOREMEDIATION	
		FOOD PROCESSING TECHNOLOGY	
IBT 364	ELECTIVE - II	BIO-NANOTECHNOLOGY	3–0-0–3
		ANIMAL AND PLANT BIOTECHNOLOGY	
		IMMUNOTECHNOLOGY	
IBT 365	ELECTIVE - III	MOLECULAR MODELING AND DRUG DESIGN	3–0-0–3
		BIOPHARMACEUTICAL ENGINEERING	
IBT 366	ELECTIVE - IV	METABOLIC ENGINEERING	3–0-0–3
		PROTEIN ENGINEERING	
IBT 367	SEMINAR		0-0-3-1
			18–2–6-22

B.Sc. (BIOMEDICAL)

FIRST YEAR - FIRST SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 111	MATHEMATICS –I	3 – 1 – 0 – 4
IPH 111	PHYSICS- I	3 – 0 – 0 – 3
ICE 111	MECHANICS OF SOLIDS	3 – 1 – 0 – 4
ICS 111	PROBLEM SOLVING USING COMPUTERS	3 – 1 – 3 – 5
IHS 111	A COURSE ON PSYCHOLOGY FOR ENGINEERS	3 – 0 – 0 – 3
IHS 112	COMMUNICATION SKILLS IN ENGLISH	3 – 0 – 0 – 3
IME 111	ENGINEERING GRAPHICS - I	0 – 0 – 3 – 1
		18 – 3 – 6 - 23

SECOND SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 121	MATHEMATICS – II	3 – 1 – 0 – 4
IPH 121	PHYSICS – II	3 – 0 – 3 – 4
ICH 121	CHEMISTRY	3 – 0 – 3 – 4
IME 121	ENGINEERING GRAPHICS - II	0 – 0 – 3 – 1
IEE 121	ELEMENTS OF ELECTRICAL AND ELECTRONICS ENGINEERING	3 – 1 – 0 – 4
IEC 121	LOGIC DESIGN	3 – 1 – 0 – 4
		15 – 3 – 9 - 21

SECOND YEAR - THIRD SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 231	MATHEMATICS - III	3 – 1 – 0 – 4
IEC 231	ANALOG ELECTRONIC CIRCUITS	3 – 1 – 0 – 4
IBM 231	ANATOMY AND PHYSIOLOGY	4 – 0 – 0 – 4
IEE 231	NETWORK ANALYSIS	3 – 1 – 0 – 4
IHS 231	BIOSTATISTICS	3 – 1 – 0 – 4
IEC 232	DIGITAL ELECTRONICS LAB	0 – 0 – 6 – 2
IEE 232	CIRCUITS SIMULATION LAB	0 – 0 – 3 – 1
		16 – 4 – 9 – 23

FOURTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IHS 241	ENGINEERING ECONOMICS & MANAGEMENT	3 – 1 – 0 – 4
IEC 241	IC SYSTEMS	3 – 0 – 0 – 3
IEE 241	SIGNALS AND SYSTEMS	3 – 1 – 0 – 4
IEC 242	LINEAR IC LAB	0 – 0 – 3 – 1
IBM 241	MICROCONTROLLERS	3 – 0 – 3 – 4
IBM 242	BIOMEDICAL INSTRUMENTATION	3 – 1 – 0 – 4
IBM 243	BIOMATERIALS	3 – 0 – 0 – 3
		18 – 3 – 6 – 23

THIRD YEAR - FIFTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IBM 351	PROJECT WORK	0 – 0 – 36 – 12
		0 – 0 – 36 – 12

SIXTH SEMESTER

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL/LAB./ CREDITS
IBM 361	BIOMEDICAL SIGNAL PROCESSING		3 – 1 – 3 – 5
IBM 362	BIOMECHANICS		4 – 0 – 0 – 4
IBM 363	ELECTIVE I	ARTIFICIAL NEURAL NETWORKS TELEMEDICINE	3 – 0 – 0 – 3
IBM364	ELECTIVE II	PATTERN RECOGNITION PHYSIOLOGICAL CONTROL SYSTEMS	3 – 0 – 0 – 3
IBM 365	ELECTIVE III	DRUG DELIVERY IMAGE PROCESSING	3 – 0 – 0 – 3
IBM 366	ELECTIVE IV	EMBEDDED SYSTEMS TISSUE ENGINEERING	3 – 0 – 0 – 3
IBM 367	SEMINAR		0 – 0 – 3 - 1
			19 – 1 – 6 – 22

B.Sc. (CHEMICAL)

FIRST YEAR - I SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 111	MATHEMATICS –I	3–1-0–4
IPH 111	PHYSICS- I	3–0-0–3
ICE 111	MECHANICS OF SOLIDS	3–1-0–4
ICS 111	PROBLEM SOLVING USING COMPUTERS	3–1-3–5
IHS 111	A COURSE ON PSYCHOLOGY FOR ENGINEERS	3–0-0–3
IHS 112	COMMUNICATION SKILLS IN ENGLISH	3–0-0–3
IME 111	ENGINEERING GRAPHICS - I	0–0-3–1
		18–3-6-23

SECOND SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 121	MATHEMATICS – II	3–1-0–4
IPH 121	PHYSICS – II	3–0-3–4
ICH 121	CHEMISTRY	3–0-3–4
IME 121	ENGINEERING GRAPHICS - II	0–0-3–1
ICHM 121	CHEMICAL PROCESS CALCULATIONS	3–1-0–4
ICHM 122	CHEMICAL ENGINEERING THERMODYNAMICS-I	3–1-0–4
		15–3–9-21

SECOND YEAR - THIRD SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 231	MATHEMATICS - III	3–1-0–4
ICHM 231	FLUID FLOW OPERATIONS	3-0-6-5
ICHM 232	CHEMICAL ENGINEERING THERMODYNAMICS-II	3-1-0-4
ICHM 233	PROCESS PLANT MATERIALS	3-0-0-3
ICH 231	ORGANIC CHEMISTRY-I	4-0-0-4
ICH 232	ORGANIC CHEMISTRY-II	3-0-0-3
		19- 2 -6 –23

FOURTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IHS 241	ENGINEERING ECONOMICS & MANAGEMENT	3–1-0–4
ICHM 241	CHEMICAL REACTION ENGINEERING	3-1-0-4
ICHM 242	HEAT TRANSFER OPERATIONS	3-0-6-5
ICHM 243	MASS TRANSFER-I	3-0-0-3
ICH 241	INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS	3-0-0-3
IBT 231	BIO-CHEMISTRY	3-0-3-4
		18-2- 9– 23

THIRD YEAR - FIFTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
ICHM 351	PROJECT WORK	0–0-36–12
		0-0- 36–12

SIXTH SEMESTER

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL/LAB./ CREDITS
ICHM 361	CHEMICAL PROCESS INDUSTRIES		3–1-0–4
ICHM 362	MASS TRANSFER-II		3–1-3–5
ICHM 363	ELECTIVE - I	PETROCHEMICALS	3–0-0–3
		INDUSTRIAL WASTEWATER ENGINEERING	
ICHM 364	ELECTIVE - II	PETROLEUM REFINERY ENGINEERING	3–0-0–3
		POLLUTION CONTROL ENGINEERING	
ICHM 365	ELECTIVE - III	SOLID WASTE ENGINEERING AND MANAGEMENT	3–0-0–3
		OIL AND GAS RESERVOIR ENGINEERING	
ICHM 366	ELECTIVE - IV	AIR POLLUTION CONTROL AND EQUIPMENT DESIGN	3–0-0–3
		PROJECT ENGINEERING	
ICHM 367	SEMINAR		0-0-3-1
			18–2–6-22

B.Sc. (CIVIL)

FIRST YEAR - I SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 111	MATHEMATICS –I	3–1-0–4
IPH 111	PHYSICS- I	3–0-0–3
ICE 111	MECHANICS OF SOLIDS	3–1-0–4
ICS 111	PROBLEM SOLVING USING COMPUTERS	3–1-3–5
IHS 111	A COURSE ON PSYCHOLOGY FOR ENGINEERS	3–0-0–3
IHS 112	COMMUNICATION SKILLS IN ENGLISH	3–0-0–3
IME 111	ENGINEERING GRAPHICS - I	0–0-3–1
		18–3-6-23

SECOND SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 121	MATHEMATICS – II	3–1-0–4
IPH 121	PHYSICS – II	3–0-3–4
ICH 121	CHEMISTRY	3–0-3–4
IME 121	ENGINEERING GRAPHICS - II	0–0-3–1
ICE 121	BUILDING SCIENCE AND TECH.	3–1-0–4
ICE 122	MECHANICS OF STRUCTURES	3–1-0–4
		15–3–9-21

SECOND YEAR - THIRD SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 231	MATHEMATICS – III	3–1-0–4
ICE 231	BASIC REINFORCED CONCRETE DESIGN	3-1-0-4
ICE 232	FLUID MECHANICS	3-1-0-4
ICE 233	GEOTECHNICAL ENGG.	3-1-0-4
ICE 234	SURVEYING	3-1-0-4
ICE 235	SURVEYING PRACTICE	0-0-3-1
ICE 236	MATERIAL TESTING LABORATORY	0-0-6-2
		15-5-9-23

FOURTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IHS 241	ENGINEERING ECONOMICS & MANAGEMENT	3–1-0–4
ICE 241	HIGHWAY ENGG.	3-1-0-4
ICE 242	BUILDING DESIGN AND DRAWING	0-0-3-1
ICE 243	WATER SUPPLY ENGG.	4-0-0-4
ICE 244	BASIC STRUCTURAL STEEL DESIGN	3-1-0-4
ICE 245	ANALYSIS OF INDETERMINATE STRUCTURES	3-1-0-4
ICE 246	FLUID MECHANICS LABORATORY	0-0-6-2
		16-4-9-23

THIRD YEAR- FIFTH SEMESTER:

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
ICE 351	PROJECT WORK	0–0-36–12
		0–0-36-12

SIXTH SEMESTER:

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL/LAB./ CREDITS
ICE 361	ADVANCED CONCRETE TECHNOLOGY		3–1-0–4
ICE 362	ESTIMATING AND COSTING		3–1-0–4
ICE 363	ELECTIVE -1	PRESTRESSED CONCRETE DESIGN	2–1-0–3
		ADVANCED RCC DESIGN	
ICE 364	ELECTIVE -2	WASTE WATER MANAGEMENT	3–0-0–3
		AIR POLLUTION AND CONTROL	
ICE 365	ELECTIVE -3	RAILWAY ENGINEERING AND AIRPORT PLANNING	2–1-0–3
		PAVEMENT MATERIAL AND DESIGN	
ICE 366	ELECTIVE – 4	GROUND IMPROVEMENT TECHNIQUE	3–0-0–3
		APPLIED SOIL ENGINEERING	
ICE 367	SEMINAR		0-0-3-1
ICE 368	ENVIRONMENTAL ENGG. LABORATORY		0-0-3-1
ICE 369	COMPUTER AIDED DESIGN LABORATORY		0-0-3-1
			17–4–9-23

B.Sc. (COMPUTER SCIENCE)

FIRST YEAR - I SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 111	MATHEMATICS –I	3–1-0–4
IPH 111	PHYSICS- I	3–0-0–3
ICE 111	MECHANICS OF SOLIDS	3–1-0–4
ICS 111	PROBLEM SOLVING USING COMPUTERS	3–1-3–5
IHS 111	A COURSE ON PSYCHOLOGY FOR ENGINEERS	3–0-0–3
IHS 112	COMMUNICATION SKILLS IN ENGLISH	3–0-0–3
IME 111	ENGINEERING GRAPHICS - I	0–0-3–1
		18–3-6-23

SECOND SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 121	MATHEMATICS – II	3–1-0–4
IPH 121	PHYSICS – II	3–0-3–4
ICH 121	CHEMISTRY	3–0-3–4
ICS 121	JAVA PROGRAMMING	3–1-3–5
ICS 122	COMPUTER ORGANIZATION AND ARCHITECTURE	3–1-0–4
		15–3–9-21

SECOND YEAR - THIRD SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 231	MATHEMATICS - III	3–1-0–4
ICS 231	DATA STRUCTURES	3–1-3–5
ICS 232	SWITCHING CIRCUITS AND LOGIC DESIGN	3–1-3–5
ICS 233	SOFTWARE DESIGN USING OBJECT ORIENTED PARADIGM	3–0-6–5
IEC 231	ANALOG ELECTRONIC CIRCUITS	3–1-0–4
		15–5–9-23

FOURTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IHS 241	ENGINEERING ECONOMICS & MANAGEMENT	3–1-0–4
ICS 241	MICROPROCESSORS	3–0-6–5
ICS 242	DATABASE MANAGEMENT SYSTEMS	2–1-3–4
ICS 243	OPERATING SYSTEMS	2–1-0–3
ICS 244	DESIGN AND ANALYSIS OF ALGORITHMS	2–1-0–3
IEE 241	SIGNALS AND SIGNAL PROCESSING	3–1-0–4
		15–6–6-23

THIRD YEAR - FIFTH SEMESTER:

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
ICS 351	PROJECT WORK	0–0-36–12
		0–0-36-12

SIXTH SEMESTER:

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL/LAB. / CREDITS
ICS 361	COMPUTER COMMUNICATION AND NETWORKS		3–1-0–4
ICS 362	COMPILER DESIGN		3–1-3–5
ICS 363	ELECTIVE - I	BIG DATA ANALYTICS	3–0-0–3
		COMPUTER GRAPHICS	
ICS 364	ELECTIVE - II	PRINCIPLES OF CRYPTOGRAPHY	3–0-0–3
		MOBILE APPLICATION DEVELOPMENT	
ICS 365	ELECTIVE - III	DIGITAL IMAGE PROCESSING	3–0-0–3
		SOFTWARE TESTING AND ANALYSIS	
ICS 366	ELECTIVE - IV	PRINCIPLES OF PROGRAMMING LANGUAGES	3–0-0–3
		MACHINE LEARNING	
ICS 367	SEMINAR		0-0-3-1
			18–2–6-22

B.Sc. (ELECTRICAL & ELECTRONICS)

FIRST YEAR - FIRST SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 111	MATHEMATICS –I	3–1-0–4
IPH 111	PHYSICS- I	3–0-0–3
ICE 111	MECHANICS OF SOLIDS	3–1-0–4
ICS 111	PROBLEM SOLVING USING COMPUTERS	3–1-3–5
IHS 111	A COURSE ON PSYCHOLOGY FOR ENGINEERS	3–0-0–3
IHS 112	COMMUNICATION SKILLS IN ENGLISH	3–0-0–3
IME 111	ENGINEERING GRAPHICS - I	0–0-3–1
		18–3-6-23

SECOND SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 121	MATHEMATICS – II	3–1-0–4
IPH 121	PHYSICS – II	3–0-3–4
ICH 121	CHEMISTRY	3–0-3–4
IME 121	ENGINEERING GRAPHICS - II	0–0-3–1
IEE 121	ELEMENTS OF ELECTRICAL AND ELECTRONICS ENGINEERING	3–1-0–4
IEC 121	LOGIC DESIGN	3–1-0–4
		15–3–9-21

SECOND YEAR - THIRD SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 231	MATHEMATICS - III	3–1-0–4
IEC 231	ANALOG ELECTRONICS CIRCUITS	3–1-0–4
IEC 233	ELECTROMAGNETIC THEORY	3–1-0–4
IEE 231	NETWORK ANALYSIS	3–1-0–4
IEE 234	MICROCONTROLLERS	3–1-0–4
IEC 232	DIGITAL ELECTRONICS LABORATORY	0–0-6–2
IEE 232	CIRCUITS SIMULATION LABORATORY	0–0-3–1
		15–5–9-23

FOURTH SEMESTER

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL/LAB./ CREDITS
IHS 241	ENGINEERING ECONOMICS & MANAGEMENT		3–1-0–4
IEC 241	IC SYSTEMS		3–1-0–4
IEE 241	SIGNALS AND SIGNAL PROCESSING		3–1-0–4
IEC/IEE 243	ELECTIVE-I	VLSI DESIGN POWER SYSTEM ANALYSIS	3–1-0–4
IEC/IEE 244	ELECTIVE-II	DSD USING VERILOG ELECTRICAL MACHINES	3–1-0–4
IEC 242	LINEAR IC LABORATORY		0–0-3–1
IEE 242	MICROCONTROLLER LABORATORY		0–0-6–2
			15–5–9-23

THIRD YEAR - FIFTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IEC/IEE 351	PROJECT WORK	**0–0-36-12**

SIXTH SEMESTER

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL/LAB./ CREDITS
IEC 361	LINER AND DIGITAL CONTROL SYSTEMS		3–1-0–4
IEE 361	MEASUREMENT AND INSTRUMENTATION		3–1-3–5
IEC/IEE 362	ELECTIVE III	ANALOG COMMUNICATION	3–0-0–3
		SOLID STATE LIGHTING AND CONTROLS	
		MATLAB FOR ENGINEERING	
		DIGITAL SIGNAL PROCESSING	
IEC/IEE 363	ELECTIVE IV	DIGITAL COMMUNICATION	3–0-0–3
		LIGHTING SCIENCE: DEVICES AND SYSTEMS	
		OBJECT ORIENTED PROGRAMMING USING C++	
		LINEAR ALGEBRA FOR SIGNAL PROCESSING	
IEC/IEE 364	ELECTIVE V	OPTICAL FIBER COMMUNICATION	3–0-0–3
		LIGHTING CONTROLS: TECHNOLOGY AND APPLICATIONS	
		SOFT COMPUTING	
		EMBEDDED SYSTEM DESIGN	
IEC/IEE 365	ELECTIVE VI	CIPHER SYSTEM	3–0-0–3
		ENERGY AUDITING & MANAGEMENT	
		DATA STRUCTURES AND ALGORITHMS	
		COMPUTER ORGANIZATION AND ARCHITECTURE	
IEC/ IEE 366	SEMINAR		0-0-3-1
			18–2–6-22

B.Sc. (MECHANICAL)

FIRST YEAR - I SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 111	MATHEMATICS – I	3 – 1 – 0 – 4
IPH 111	PHYSICS- I	3 – 0 – 0 – 3
ICE 111	MECHANICS OF SOLIDS	3 – 1 – 0 – 4
ICS 111	PROBLEM SOLVING USING COMPUTERS	3 – 1 – 3 – 5
IHS 111	A COURSE ON PSYCHOLOGY FOR ENGINEERS	3 – 0 – 0 – 3
IHS 112	COMMUNICATION SKILLS IN ENGLISH	3 – 0 – 0 – 3
IME 111	ENGINEERING GRAPHICS – I	0 – 0 – 3 – 1
		18 – 3 – 6 – 23

SECOND SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 121	MATHEMATICS – II	3 – 1 – 0 – 4
IPH 121	PHYSICS – II	3 – 0 – 3 – 4
ICH 121	CHEMISTRY	3 – 0 – 3 – 4
IME 121	ENGINEERING GRAPHICS - II	0 – 0 – 3 – 1
IME 122	BASIC MECHANICAL ENGINEERING	3 – 1 – 0 – 4
IME 123	STRENGTH OF MATERIALS	3 – 1 – 0 – 4
		15 – 3 – 9 – 21

SECOND YEAR - THIRD SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 231	MATHEMATICS – III	3 – 1 – 0 – 4
IME 231	THERMAL ENGINEERING	3 – 1 – 0 – 4
IME 232	MANUFACTURING PROCESS ENGINEERING	4 – 0 – 0 – 4
IME 233	MATERIAL SCIENCE AND METALLURGY	3 – 0 – 0 – 3
IME 234	FLUID MECHANICS	3 – 0 – 0 – 3
IME 235	AUTOMOBILE ENGINEERING	3 – 0 – 0 – 3
IME 236	COMPUTER AIDED MECHANICAL DRAWING	0 – 0 – 6 – 2
IME 237	STRENGTH OF MATERIALS LABORATORY	0 – 0 – 3 – 1
		19 – 2 – 9 – 24

FOURTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IHS 241	ENGINEERING ECONOMICS & MANAGEMENT	3 – 1 – 0 – 4
IME 241	THEORY OF MACHINES	3 – 1 – 0 – 4
IME 242	DESIGN OF MACHINE ELEMENTS	3 – 1 – 0 – 4
IME 243	INTERNAL COMBUSTION ENGINES	3 – 0 – 0 – 3
IME 244	METROLOGY AND MEASUREMENTS	3 – 0 – 0 – 3
IME 245	FLUID MECHANICS LABORATORY	0 – 0 – 3 – 1
IME 246	WORKSHOP PRACTICE	0 – 0 – 6 – 2
IME 247	THERMAL ENGINEERING LABORATORY	0 – 0 – 3 – 1
		15 – 3 – 12 – 22

THIRD YEAR - FIFTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IME 351	PROJECT WORK	**0–0-36-12**

SIXTH SEMESTER

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL/LAB./ CREDITS
IME 361	PRODUCTION AND OPERATIONS MANAGEMENT		3–1-0–4
IME 362	HEAT TRANSFER		3–1-3–5
IME 363	ELECTIVE – I	AUTOMATIC CONTROL ENGINEERING	3–0-0–3
		SUPPLY CHAIN AND LOGISTICS MANAGEMENT	
IME 364	ELECTIVE – II	ELEMENTS OF MECHATRONICS SYSTEMS	3–0-0–3
		NON – CONVENTIONAL ENERGY SOURCES	
IME 365	ELECTIVE – III	HEAT TREATMENT OF METALS AND ALLOYS	3–0-0–3
		POWER PLANT ENGINEERING	
IME 366	ELECTIVE – IV	OPERATIONS RESEARCH	3–0-0–3
		ORGANIZATIONAL BEHAVIOR	
IME 367	SEMINAR		0-0-3-1
			18-2-6-22

B.Sc. (MECHATRONICS)

FIRST YEAR - I SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 111	MATHEMATICS –I	3–1-0–4
IPH 111	PHYSICS- I	3–0-0–3
ICE 111	MECHANICS OF SOLIDS	3–1-0–4
ICS 111	PROBLEM SOLVING USING COMPUTERS	3–1-3–5
IHS 111	A COURSE ON PSYCHOLOGY FOR ENGINEERS	3–0-0–3
IHS 112	COMMUNICATION SKILLS IN ENGLISH	3–0-0–3
IME 111	ENGINEERING GRAPHICS - I	0–0-3–1
		18–3-6-23

SECOND SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 121	MATHEMATICS – II	3–1-0–4
IPH 121	PHYSICS – II	3–0-3–4
ICH 121	CHEMISTRY	3–0-3–4
IME 121	ENGINEERING GRAPHICS - II	0–0-3–1
IME 122	BASIC MECHANICAL ENGINEERING	3–1-0–4
IEE 121	ELEMENTS OF ELECTRICAL AND ELECTRONICS ENGINEERING	3–1-0–4
		15–3–9-21

SECOND YEAR - THIRD SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 231	MATHEMATICS - III	3–1-0–4
IMET 231	ELEMENTS OF MECHATRONICS SYSTEMS	3–0–0–3
IMET 232	KINEMATICS OF MACHINES	2–1–0–3
IMET 233	MATERIAL SCIENCE AND ENGINEERING	3–0–0–3
IMET 234	ANALOG AND DIGITAL SYSTEM DESIGN	3–0–0–3
IEC 231	ANALOG ELECTRONICS CIRCUITS	3–1–0–4
IMET 235	CAD LABORATORY	0–0–3–1
IEC 232	DIGITAL ELECTRONICS LABORATORY	0–0–6–2
		17–3–9-23

FOURTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IHS 241	ENGINEERING ECONOMICS & MANAGEMENT	3–1-0–4
IMET 241	MICROCONTROLLER AND APPLICATIONS	3–0–0–3
IMET 242	PROGRAMMABLE LOGIC CONTROLLER	3–0–3–4
IMET 243	AUTOMATED MANUFACTURING SYSTEMS	3–0–0–3
IMET 244	INDUSTRIAL ROBOTS	3–0–0–3
IEE 241	SIGNALS AND SIGNAL PROCESSING	3–1-0–4
IEE 242	MICROCONTROLLER LABORATORY	0–0-6–2
		18–2–9–23

THIRD YEAR - FIFTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/ LAB./ CREDITS
IMET 351	POJECT WORK	0–0-36–12
		0–0-36-12

SIXTH SEMESTER

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL /LAB./ CREDITS
IMET 361	MICRO ELECTRO MECHANICAL SYSTEMS		4–0-0–4
IMET 362	ELECTRIC DRIVES		4–0-3–5
IMET 363	ELECTIVE - I	AUTOMOBILE ENGINEERING	3–0-0–3
IMET 364	ELECTIVE - II	AUTOMOTIVE COMPONENT DESIGN AUTOTRONICS HYBRID AND ELECTRIC VEHICLES INTELLIGENT CONTROLLERS MACHINE VISION AND IMAGE PROCESSING ROBOT DYNAMICS AND CONTROL ROBOTIC PATH PLANNING	3–0-0–3
IMET 365	ELECTIVE - III	ADDITIVE MANUFACTURING	3–0-0–3
IMET 366	ELECTIVE - IV	TECHNOLOGIES COMPUTER NETWORKS & COMMUNICATION PROTOCOL. DATABASE MANAGEMENT SYSTEMS DYNAMICS AND CONTROL OF MECHATRONICS SYSTEMS FPGA BASED DIGITAL SYSTEM DESIGN INTRODUCTION TO ALGORITHMS MACHINE TOOL TECHNOLOGY NANOTECHNOLOGY NOISE VIBRATION AND HARSHNESS PRINCIPLES OF SOFTWARE ENGINEERING AND TESTING PRODUCTION AND OPERATION MANAGEMENT SYSTEM MODELING & SIMULATION WIRELESS SENSOR NETWORKS MACHINE LEARNING	3–0-0–3
IMET 367	SEMINAR		0-0-3-1
			18–2–6-22

B.Sc. (AERONAUTICAL/AEROSPACE/AVIATION)

FIRST YEAR - I SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 111	MATHEMATICS –I	3–1-0–4
IPH 111	PHYSICS- I	3–0-0–3
ICE 111	MECHANICS OF SOLIDS	3–1-0–4
ICS 111	PROBLEM SOLVING USING COMPUTERS	3–1-3–5
IHS 111	A COURSE ON PSYCHOLOGY FOR ENGINEERS	3–0-0–3
IHS 112	COMMUNICATION SKILLS IN ENGLISH	3–0-0–3
IME 111	ENGINEERING GRAPHICS - I	0–0-3–1
		18–3-6-23

SECOND SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IMA 121	MATHEMATICS – II	3 – 1 – 0 – 4
IPH 121	PHYSICS – II	3 – 0 – 3 – 4
ICH 121	CHEMISTRY	3 – 0 – 3 – 4
IME 121	ENGINEERING GRAPHICS - II	0 – 0 – 3 – 1
IME 123	STRENGTH OF MATERIALS	3 – 1 – 0 – 4
IAV 121	INTRODUCTION TO AEROSPACE ENGINEERING AND AVIONICS	3 – 1 – 0 - 4
		15 – 3 – 9 – 21

B.Sc. (ARCHITECTURE)

FIRST YEAR - I SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IAE 111	ARCHITECTURAL DESIGN & DETAILING –STUDIO - I	2-6-0-8
IAE 112	STRUCTURAL & CONSTRUCTION SYSTEMS –STUDIO - I	2-2-2-5
IAE 113	ARCHITECTURAL REPRESENTATION – STUDIO - I	1-1-4-4
IAE 114	BUILDING MATERIALS	1-0-2-2
IAE 115	HISTORY OF BUILT ENVIRONMENT - I	1-0-2-2
IAE 116	PRINCIPLES OF ENVIRONMENTAL DESIGN	2-0-0-2
		9–9-10-23

SECOND SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IAE 121	ARCHITECTURAL DESIGN & DETAILING – STUDIO - II	2-6-0-8
IAE 122	STRUCTURAL & CONSTRUCTION SYSTEMS – STUDIO - II	2-2-2-5
IAE 123	ARCHITECTURAL REPRESENTATION – STUDIO - II	1-1-3-3
IAE 124	BUILDING SERVICES - I	1-0-2-2
IAE 125	HISTORY OF BUILT ENVIRONMENT - II	1-0-2-2
IAE 126	PRINCIPLES OF LANDSCAPE DESIGN	2-0-0-2
		9–9–9-22

SECOND YEAR - THIRD SEMESTER

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL/LAB./ CREDITS
IAE 231	ARCHITECTURAL DESIGN & DETAILING – STUDIO - III		2-6-0-8
IAE 232	STRUCTURAL & CONSTRUCTION SYSTEMS – STUDIO - III		2-2-2-5
IAE 233	ARCHITECTURAL REPRESENTATION – STUDIO - III		0-2-3-3
IAE 234	BUILDING SERVICES - II		1-0-2-2
IAE 235	HISTORY OF BUILT ENVIRONMENT - III		2-0-0-2
IAE 236	PRINCIPLES OF CLIMATIC DESIGN		2-0-0-2
IAE 237	ELECTIVE - I	METAL ART	0-0-2-1
		GLASS ART	
		CLAY ART	
		WOOD ART	
			9–10–9-23

FOURTH SEMESTER

SUBJECT CODE	SUBJECT		THEORY/TUTORIAL/LAB./ CREDITS
IAE 241	ARCHITECTURAL DESIGN & DETAILING – STUDIO - IV		2-6-0-8
IAE 242	STRUCTURAL & CONSTRUCTION SYSTEMS – STUDIO - IV		2-2-2-5
IAE 243	ARCHITECTURAL REPRESENTATION – STUDIO - IV		0-2-3-3
IAE 244	BUILDING SERVICES - III		1-0-2-2
IAE 245	HISTORY OF BUILT ENVIRONMENT - IV		2-0-0-2
IAE 246	PRINCIPLES OF SUSTAINABLE DESIGN		2-0-0-2
IAE 247	ELECTIVE - II	CREATIVE PHOTOGRAPHY	0-0-2-1
		CREATIVE WRITING	
		CREATIVE FASHION	
		CREATIVE GARDENING	
			9–10–9-23

THIRD YEAR- FIFTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IAE 351	ARCHITECTURAL DESIGN & DETAILING – STUDIO - V	2-6-0-8
IAE 352	STRUCTURAL & CONSTRUCTION SYSTEMS – STUDIO - V	2-2-2-5
IAE 353	WORKING DRAWING & DETAILING – STUDIO - I	1-1-3-3
IAE 354	PROJECT MANAGEMENT	1-0-2-2
IAE 355	HISTORY OF BUILT ENVIRONMENT - V	1-0-2-2
IAE 356	PRINCIPLES OF URBAN DESIGN	2-0-0-2
		9–9–9-22

SIXTH SEMESTER

SUBJECT CODE	SUBJECT	THEORY/TUTORIAL/LAB./ CREDITS
IAE 361	ARCHITECTURAL DESIGN & DETAILING – STUDIO - VI	2-6-0-8
IAE 362	STRUCTURAL & CONSTRUCTION SYSTEMS – STUDIO - VI	2-2-2-5
IAE 363	WORKING DRAWING & DETAILING – STUDIO - II	1-1-3-3
IAE 364	RESEARCH TECHNIQUES	1-0-2-2
IAE 365	CONTEMPORARY BUILT ENVIRONMENT	1-0-2-2
IAE 366	PRINCIPLES OF HOUSING & ECONOMICS	2-0-0-2
		9–9–9-22

DETAILED SYLLABUS

I SEMESTER

(COMMON TO ALL BRANCHES EXCEPT ARCHITECTURE)

MATHEMATICS - I

IMA 111 **3-1-0-4**

Successive differentiation, polar co-ordinates, angle between polar curves, derivative of arc length, curvature, radius of curvature and evolutes. (12 hours)

Rolle's Theorem, mean value theorems - Lagrange's and Cauchy's mean value theorems, Taylor's theorem, Maclaurin's series development, indeterminate forms and L'Hospital's Rule. (6 hours)

Infinite series, series with positive terms - test of convergence, comparison test, D'Alembert's ratio test, Cauchy's root test, Raabe's test, integral test, alternating series - Leibnitz's rule, power series, radius of convergence and interval of convergence. (6 hours)

Reduction formulae, curve tracing, application of integration to find arc length, area of the plane regions, surface area of revolution, volume of revolution. (10 hours)

Analytical solid geometry – Planes and Straight line (basic revision). Spheres, section of sphere by planes, right circular cone and right circular cylinder. (8 hours)

Interpolation and application: Finite differences- forward, backward, central and divided differences, Newton-Gregory interpolation, Lagrange's interpolation and Newton's divided difference polynomial. (6 hours)

TEXT/ REFERENCES:

- Calculus and Analytical Geometry - IV Edn., George B. Thomas Jr. (1992), Addison Wesley Publications.
- Calculus & Analytical Geometry - George B. Thomas Jr & Ross L. Finney (1998), Addison Wesley Publications.
- Numerical methods- Andrew D. Booth (1966), Butterworth & Co. (Publishers) Ltd.
- Introductory Methods of Numerical Analysis - S. S. Sastry (2012), PHI Learning Pvt. Ltd.
- 5. Higher Engineering Mathematics, Grewal B. S., Grewal J. S. (2015), Kanna Publishers.

PHYSICS - I

IPH 111 **3-0-0-3**

Optics: Interference of Light Waves: Conditions for interference, Young's double-slit experiment, Intensity distribution of the double-slit interference pattern, Phasor addition of waves, Change of phase due to reflection, Interference in thin films, The Michelson Interferometer. (10 hours)

Diffraction Patterns and Polarization: Introduction to diffraction patterns, Diffraction patterns from narrow slits, Resolution of single-slit and circular apertures, The diffraction grating, Diffraction of X-rays by crystals, Polarization of light waves.

Modern Physics: Introduction to Quantum Physics: Blackbody radiation and Planck's hypothesis, The photoelectric effect, The Compton effect, Photons and electromagnetic waves, The wave properties of particles, The quantum particle, The double-slit experiment revisited, The uncertainty principle.

Quantum Mechanics: An interpretation of quantum mechanics, A particle in a box, The particle under boundary conditions, The Schrodinger equation, A particle in a well of finite height, Tunneling through a potential energy barrier, Applications of tunneling, The simple harmonic Oscillator.

Atomic Physics: Atomic spectra of gases, Early models of the atom, Bohr's model of the hydrogen atom, The quantum model of the hydrogen atom, The wave functions for hydrogen, Physical interpretation of the quantum numbers, More on atomic spectra: visible and X-ray, Spontaneous and stimulated transitions, Lasers. (18 hours)

Solid state Physics:Molecules and Solids: Molecular bonds, Energy states and spectra of molecules, Bonding in solids, Free-electron theory of metals, Band theory of solids, Electrical conduction in metals, insulators, and semiconductors, Semiconductor Devices, Superconductivity. (8 hours)

TEXT/ REFERENCES:

- Serway & Jewett; **Physics for Scientists and Engineers with Modern Physics**; Volume 2; 6e, Thomson.
- Halliday, Resnick, Krane; Physics; Volume 2; 5e, John Wiley and Sons, Inc.

MECHANICS OF SOLIDS

ICE 111 3-1-0-4

PART-A: MECHANICS OF RIGID BODIES:

Introduction: basic principles and concepts (1 hour)

Resultant of coplanar concurrent and non-concurrent force system: Resolution, composition, moment of force, Varignons theorem, couple, application problems. (6 hours)

Equilibrium of Coplanar concurrent and noncurrent force system: Conditions of Equilibrium, Space and Free body diagram, Lami's theorem- application problems. Support reaction, types of loading, friction- application problems. (6 hours)

Centroid and Moment of Inertia**:** Simple and composite areas, application problems. (8 hours)

Kinetics: Applications of D'Alembert's, Work-Energy and Impulse Momentum principles (9 hours)

PART-B: MECHANICS OF DEFORMABLE BODIES:

Simple Stresses and Strains: normal stress and strain, mechanical properties of materials, Hooke's law, modulus of elasticity, tension test on ductile and brittle materials, factor of safety, allowable stress, Stresses and deformations in tapered bars, stepped bars, Poisson's ratio, shear stress and shear strain, modulus of rigidity, relation between modulus of elasticity, modulus of rigidity and bulk modulus., application problems. (9 hours)

Statically indeterminate members: Compound bars, thermal stress (6 hours)

Stresses in thin cylinder: hoop, longitudinal and shear stresses. Change in dimensions due to the fluid pressure, joint efficiency and application problems. (3 hours)

TEXT/ REFERENCES:

- Meriam & Kraige, Engineering Mechanics, John Wiley & Sons.
- Beer & Johnston, Vector Mechanics for Engineers, Tata McGraw Hill
- Singer F.L., Engineering Mechanics, Harper & Row.
- E. P. Popov, Mechanics of Materials, S.I. Version, PHI.
- Pytel and Singer, Strength of Materials, Harper & Collins.
- I.H.Shames – Engineering Mechanics – Statics & Dynamics II Edn. (SI Version) – Prentice Hall.
- S.P. Timoshenko and D.H. Young – Engineering Mechanics – Mc Graw Hill.
- Bhavikatti & Rajasekharappa, Engineering Mechanics, New Age International
- Bhavikatti S.S., Strength of Materials, Vikas Publishers.
- Basavarajaiah & Mahadevapp, Strength of Materials, CBS Publishers.

PROBLEM SOLVING USING COMPUTERS

ICS 111 **3-1-3–5**

INTRODUCTION TO COMPUTERS: Block diagram of a computer, computer memories, and operating system basics. (1 hour)

ALGORITHMS AND FLOWCHARTS: Definitions, symbols of flowcharts, examples of flowcharts and algorithms for simple ones, examples of flowcharts and algorithms for complex problems. (3 hours)

BEGINNING WITH C++: Applications of C++, sample program, C++ statements, class example, structure of C++ program, creating the source file, compiling and linking. (1 hour)

TOKENS AND EXPRESSIONS: Tokens, keywords, identifiers and constants, basic data types, user defined data types, derived data types, symbolic constants, type compatibility, declaration of variables, dynamic initialization, reference variables. (3 hours)

OPERATORS AND EXPRESSIONS: Operator precedence and associativity, arithmetic operators, relational operators, logical operators, increment and decrement operators, bitwise operators, assignment operators, conditional operator, comma operator, type cast operator, type

conversions, implicit conversions, arithmetic expressions, evaluation of expressions, special assignment expressions. (4 hours)

CONTROL STRUCTURES: Statements and blocks, simple if, if-else, nested if statements, else-if ladder, switch–case statement, looping constructs- entry controlled and exit controlled loops, break and continue statements, exit statement, problem solving using above statements. (6 hours)

ARRAYS & STRINGS: 1-D arrays- Declaration and Initialization, programs on array manipulation, sorting (selection and bubble sort techniques), searching (linear and binary search techniques), 2-D arrays-basics, simple programs on matrix manipulation, strings-operation on strings, built-in string handling functions, programs on strings. (6 hours)

STRUCTURED PROGRAMMING – FUNCTIONS: Main function, function prototyping, call by reference, return by reference, inline functions, default arguments, const arguments, function overloading, Functions in Implementation of different problems, Recursive functions. (5 hours)

STRUCTURES AND POINTERS: Structures - basic operations and programs, advantages of structures over arrays, array of structures, Pointers-pointers to simple variables, pointers to arrays, basic operation on pointers and programs. (4 hours)

INTRODUCTION TO OOP: Benefits of OOP, Object oriented languages over POP, Basic concepts of OOP, Classes and Objects – access specifier, member function and data, scope resolution operator, this pointer. Friend function, Static members, Objects and functions, Objects and array, Dynamic Memory Allocation and Deallocation. (8 hours)

CONSTRUCTORS AND DESTRUCTORS: Constructors, Destructors, Inheritance: Introduction to Inheritance, Base Class and Derived Class Pointers, Function Overriding, Base Class Initialization, The Protected Access Specifier, Different Kinds of Inheritance, Order of Invocation of Constructors and Destructors. The Need for Virtual Functions, Virtual Functions. Introduction to Function Template and Class Template. (7 hours)

PROBLEM SOLVING USING COMPUTERS LABORATORY

Implementing simple programs in C++ using simple operators and expressions, Control structures - Decision making and branching ,Looping ,1D Arrays, 2D Arrays, Strings, Functions, Structure and pointers, Object Oriented Programming-Classes and objects,Constructors, destructors, virtual functions, Inheritance, Problem Solving using MATLAB

TEXT/ REFERENCES:

- Bjarne Stroustrup, “The C++ Programming Language”,(4e), Addison Wesley Publication, 2013
- Robert Lafore, “Object Oriented Programming in C++”, (4e), Galgotia Publication, 2001
- Sourav Sahay, “Object oriented programming with C++”,(2e), Oxford Higher Education, 2012.
- E. Balaguruswamy, “Object Oriented Programming with C++”, (6e), Tata McGraw Hill Publication, 2014

- Stephen Prata, "C++ Primer Plus",(6e), Addison Wesley Publication, 2011
- Herbert Schield, "The Complete Reference C++", (4e), TMH, 2005.

A COURSE ON PSYCHOLOGY FOR ENGINEERS

IHS 111 **3-0-0-3**

Introduction to Psychology: The Philosophical origin of Psychology, Modern schools of Psychology, Scope of Psychology and important methods (4 hours)

Learning: Classical conditioning, Operant conditioning, learning by observation (4 hours)

Intelligence: Intelligence – theories of Intelligence, Assessing intelligence, Emotional intelligence. (3 hours)

Perception and attribution: Definitions, factors influencing perception, perceptual organization, theories of attribution (3 hours)

Personality: Psychodynamic approach, Trait approach, Behavioural and Humanistic approach, Assessment of personality (4 hours)

Introduction to Industrial/Organizational Psychology: Evolution; Contributions of F W Taylor, F Gilbreth and Elton Mayo; Scope of Industrial/Organizational Psychology, Limitations of Industrial Psychology; Research Methodology (5 hours)

Managerial Psychology: Types of human occupation, Business and Profession, Classification of Industries; Manager and Management, Classification of managers, Functions of managers, Principles of management, Types of planning and plans (5 hours)

Human Relations Psychology: Behavioural management theories-Abraham Maslow, Herzberg and McGregor; Leadership Styles and Leadership Grid. (3 hours)

Consumer Psychology: Types of markets and products; Selling and marketing, Role of marketing, Functions of marketing; Market segmentation, Marketing mix, Product Life Cycle and marketing strategies; Data collection methods (5 hours)

TEXT/ REFERENCES:

- Feldman, R. S. (1993). Understanding psychology. New York: McGraw-Hill.
- Myers, D. G. (2005). *Exploring psychology*. New York, NY: Worth Publishers.
- Morgan and King (Latest edition) *Introduction to Psychology*. New York: McGraw-Hill.
- Paul E. Spector (2016), "Industrial and Organizational Psychology: Research and Practice", Wiley.
- Michael G. Aamodt (2013), "Industrial Psychology", Cengage.
- May Smith (2007), "An Introduction To Industrial Psychology", Read Books.
- Naylor J. C and Blum M. L (2003), "Industrial Psychology: Its Theoretical and Social Foundations", CBS.

COMMUNICATION SKILLS IN ENGLISH

IHS 112 **3-0-0-3**

Listening: Audio and Video talks and response to each of them. (4 hours)

Speaking: Speech and Presentation techniques /Group Discussion. (10 hours)

Reading: Different styles, kinds of narratives and forms. (8 hours)

Earnest Hemmingway – The Old Man and the Sea (Text for Reading)

Strategies: skimming, scanning and critical analysis

Grammar: Sentence structures: error identification and correction (4 hours)

Writing: (10 hours)

Paragraph writing

Essay writing

- Argumentative
- Narrative
- Expository

Editing

Summary writing

Statement of purpose

Resume'

TEXT/ REFERENCES:

- Stanley Fish, How to write a sentence: And how to Read one, HarperCollins, New York, 2005
- Raymond Murphy, Essential English Grammar: A Self-Study reference and Practice Book, Cambridge University Press, 2001.
- William Strunk and E B White, The elements of style, Longman, New York, 1999.
- Paul Eschholz and Alfred Rosa, Outlooks and Insights: A Reader for Writers, St Martin's Press, 1995.

ENGINEERING GRAPHICS – I

IME 111 **0-0-3-1**

Software: AutoCAD

INTRODUCTION**:** Introduction to engineering graphics, Geometrical constructions, Dimensioning and conventions of lines. (3 hours)

PROJECTION OF POINTS**:** Introduction to orthographic projection, Meaning of reference planes, Quadrants, Types of quadrants, Conventional representation of first angle projection system. Projection of points in first angle projection system only. (3 hours)

PROJECTION OF STRAIGHT LINES: Line parallel to both reference planes, Perpendicular to reference plane, Inclined to one reference plane, Inclined to both reference planes including locating traces, finding true length and inclinations. (12 hours)

PROJECTION OF PLANE SURFACES**:** Simple planes (Triangle, Square, Rectangle, Pentagon, Hexagon &Circle), Plane resting on edge and corner conditions, Surface inclined to HP & perpendicular to VP, Surface inclined to VP and perpendicular to HP, Simple cases of planes inclined to both HP & VP (Change of position method only). (9 hours)

PROJECTION OF SOLIDS: Simple solids like prisms & pyramids (Triangle, Square, Rectangle, Pentagon & Hexagon), Cone and cylinder, Solids resting on edge and corner conditions, Axis inclined to HP and parallel to VP, Inclined to VP & parallel to HP. Simple cases of axis inclined to both HP and VP (Change of position method only). (12hours)

TEXT/ REFERENCES:

- Gopalkrishna K. R. and Sudhir Gopalkrishna (2012) "A textbook of Computer Aided Engineering Drawing", 37th Edition, Subhas Stores, Bangalore.
- Bhat N. D. and V.M. Panchal (2010) "Engineering Drawing", 50th Edition, Charotar Publishing House, Anand, India.
- Venugopal K. (2002) "Engineering Drawing and Graphics + Auto CAD" Newage International Publishers, Delhi.
- Narayana K. L. and Kannaiah P (2002) "Text book on Engineering Drawing" Scitech Publications, Chennai.
- Basant Agrawal& Agrawal C M (2010) "Engineering Drawing" Tata McGraw Hill, New Delhi.

B.Sc. (BIOLOGICAL)

II SEMESTER

MATHEMATICS II

IMA 121 **3-1-0-4**

Functions with two or more variables, partial differentiation, chain rule, composite and implicit function differentiation, total differentials, error and approximation. Maxima and minima for functions of two or more variables, Lagrange's method of undetermined multipliers. (8 hours)

Multiple integrals: double and triple integrals, change of order of integration, Jacobian of polar, cylindrical and spherical coordinate systems, change of variables, Application of multiple integrals to find area and volumes. (10 hours)

Linear algebra: n-dimensional vectors, vector spaces, linear combination, linear dependence, linear independence, spanning set, basis, orthogonal and orthonormal basis, Gram-Schmidt orthogonalisation process. (8 hours)

Linear system of equations: Rank of a matrix, Elementary row operations, Gauss elimination process, consistency, Inverse of invertible matrices by row operations. (6 hours)
Vectors - Vector differentiation, Divergence, Gradient and Curl and their physical interpretation and simple applications. Vector integration, Greens theorem in the plane, Gauss Divergence theorem, Stoke's theorem and simple applications. (10 hours)
Curvilinear coordinates systems- Spherical and cylindrical coordinate systems. (2 hours)
Beta and Gamma functions & their properties. (4 hours)

TEXT/ REFERENCES:

- Calculus and Analytical Geometry - IV Edn. - George B. Thomas Jr. (1992) Addison Wesley Publications.
- Calculus & Analytical Geometry - George B. Thomas Jr & Ross L. Finney (1998), Addison Wesley Publications.
- Linear Algebra - G. H. Hadley(2002), Narosa Publishing House.
- Theory and problems of vector Analysis and an introduction to tensor analysis, Murray R. Speigel and others (2011), Tata McGraw Hill Publications.
- Higher Engineering Mathematics, Grewal B. S., Grewal J. S. (2015), Kanna Publishers.

PHYSICS – II

IPH 121 **3-0-3-4**

Electric Fields: Coulomb's law, The electric field, Continuous charge distribution, Charged particles in uniform electric field. (3 hours)

Gauss's Law: Gauss's law and derivation, Applications to various charge distributions, Conductors in electrostatic equilibrium. (3 hours)

Electric Potential: Potential difference in uniform electric field, Potential and energy due to point charges, Electric field and potential, Continuous charge distributions, Potential due to charged conductor, Applications of electrostatics. (4 hours)

Capacitance and Dielectrics: Calculating capacitance, Combinations of capacitors, Energy in a charged capacitor, Capacitors with dielectrics, Dipole in electric field, Atomic description of dielectrics. (3 hours)

Current and Resistance:Electric current, Resistance, Electrical conduction, Resistance and temperature, Superconductors, Electrical power. (3 hours)

Direct Current Circuits:Electromotive force, Resistors in series and parallel, Kirrchhoff's rules,RC circuits, Electrical meters. (3 hours)

Magnetic Fields:Magnetic fields and forces, Magnetic force acting on a current-carrying conductor, Torque on a current loop in a uniform magnetic field, Motion of a charged particle in uniform magnetic field, Applications, Hall effect. (3 hours)

Sources of the Magnetic Field:The Biot-Savart law, The magnetic force between two parallel conductors, Ampere's law, The magnetic field of a solenoid, Magnetic flux, Gauss's law in magnetism, Displacement current and the general form of Ampere's law, Magnetism in matter. (4 hours)

Faraday's Law: Faraday's law of induction, Motional emf, Lenz's law, Induced emf and electric fields, Generators and motors, Eddy currents, Maxwell's equations. (3 hours)

Inductance: Self-inductance, RL circuits, Energy in a magnetic field, mutual inductance, Oscillations in an LC circuit, The RLC circuit. (3 hours)

Alternating Current Circuits: AC sources, Resistors in an AC circuit, Inductors in an AC circuit, Capacitors in an AC circuit, The RLC series circuit, Power in an AC circuit, Resonance in a series RLC circuit, The transformer and power transmission, Rectifiers and filters. (4 hours)

TEXT/ REFERENCES:

- Serway & Jewett; Physics for Scientists and Engineers with Modern Physics; Volume 2; 6e, Thomson.
- Halliday, Resnick, Krane; Physics; Volume 2; 5e, John Wiley and Sons, Inc.

PHYSICS LABORATORY:

To perform any 12 of the following experiments:

1. Field along the axis of a coil
2. Energy band gap of a semiconductor
3. Newton's rings
4. Blackbody radiation
5. Photoelectric effect
6. Charging and discharging of a capacitor / RC time constant

7. Series and parallel resonance circuits
8. e/m –Thomson's method
9. Fermi energy of a metal
10. Hall effect
11. Zener diode characteristics
12. Hysteresis loss in magnetic materials
13. Half wave and full wave rectifier circuits, C-filter circuit
14. Resistivity of a semiconductor by four probe method

CHEMISTRY

ICH 121 **3–0-3-4**

Electrochemistry: Introduction to electrochemical cell and its types, Liquid junction potential, EMF of the cell and its determination, Standard cell, Origin of electrode potential, Single electrode potential, Nernst equation for electrode potential, Types of electrodes- hydrogen electrode, Calomel electrode and glass electrode, Numericals. (5 hours)

Chemical equilibrium: Introduction to chemical equilibrium, Laws of mass action. Relation between K_c and K_p, Le-Chatelier principle and its application.
Ionic equilibria: Arrhenius theory of electrolyte dissociation, The Ostwald dilution law, Ionic product of water, hydrolysis, hydrolysis of salts of four types, hydrolysis constant, relation between K_h, K_a/K_b and K_w, degree of hydrolysis, Common ion effect, solubility product and its applications. Numericals. (4 hours)

Thermodynamics: Terminology of thermodynamics. First law of thermodynamics. Internal energy, Enthalpy, Heat capacity, heat capacity equations at constant volume and pressure. Calculation of ΔU, ΔH and w for reversible isothermal expansion of an ideal gas.
Thermochemistry -Hess's law and its applications. Limitations of first law.
Second law of thermodynamics. Concept of entropy. Entropy change - in isothermal expansion of an ideal gas, in reversible and irreversible processes, with change of phase, Physical significance of entropy. Helmholtz Free Energy, Gibbs free Energy, Gibbs Helmholtz equation. Numericals (5hours)

Chemical Kinetics:
Rate of a reaction, order and molecularity of a reaction, rate law, integrated rate equation and half-life (first and second order reaction), energy of activation, theories of reaction rates-collision theory and transition state theory. Numericals (4hours)

Chemical bonding: Primary bonding: Ionic bond: Ionic bond formation, Factor influencing the formation of ionic bond, Lattice energy & its determination by Born-Haber cycle, Properties of ionic bond.
Covalent bond: Covalent bond formation, valence bond theory, Molecular orbital theory & their application to diatomic molecules, Concept of resonance, Valence shell electron pair repulsion concept (VSEPR), Properties of covalent bond.
Metallic bond: Structure of metals, Electron sea model, band theory of solids, conductors, semiconductors & insulators, Properties of metallic bond.
Secondary bonding: Hydrogen bond: Conditions of formation & types of hydrogen bonding with illustrative examples. Vander Waals forces. (10 hours)

Organic reactions and mechanisms: Classification of organic compounds, IUPAC system of Nomenclature, Organic reactions and their Mechanisms- Homolytic and heterolytic

fission, carbonium ions, carbanions, carbon free radicals, substitution reactions, addition reactions, elimination reactions, rearrangement reactions, Isomerism - structural and stereoisomerism. (8hours)

TEXT/ REFERENCES:

- Atkins P W, Physical chemistry, 8th Edn, Oxford University Press, Oxford,1998
- Levine IraN, Physical chemistry, 6th Edn, McGraw Hill, New York , 1998.
- James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
- P.C. Jain, M. Jain, Engineering Chemistry, 15th Edn., Dhanpat Rai and Sons, Delhi, Revised, 2006.
- Arun Bahl and B.S.Bahl, A text book of organic chemistry,18th edn., S.Chand& Co.ltd, New Delhi,2006.

CHEMISTRY LAB

1. Acid-base titration (Acidimetric/Alkalimeter)
2. Determination of hardness of water
3. Determination of chloride content of water
4. Determination of percentage of copper in brass
5. Determination of percentage of nitrogen ammonia in fertilizer
6. Determination of rate constant of hydrolysis of ethyl acetate
7. Colorimetric determination of copper
8. Conductometric titration of a Mixture of strong & weak acids vs strong base
9. Determination of pKa value of a weak acid using pH meter
10. Redox titration using potentiometer

ENGINEERING GRAPHICS –II

IME 121 **0-0-3-1**

Software: AutoCAD

INTRODUCTION**:** Importance of sectioning the object, Development of surfaces of solids, Isometric projection, Orthographic projection and its practical applications. (3 hours)

SECTIONS OF SOLIDS**:** Introduction, Horizontal vertical and inclined section planes and true shape of sections. Drawing sectional views with true shape of section. Simple cases of solids resting on HP or VP with axis perpendicular to reference planes, inclined to one reference plane. Section plane perpendicular to VP, inclined to HP and inclined to VP. (9 hours)

DEVELOPMENT OF SURFACES: Parallel line development for prisms (Triangle, Rectangle, Square, Pentagon and Hexagon) and cylinders (Including simple cut solids), Radial line development for pyramids (Triangle, Square, Rectangle, Pentagon and Hexagon) and cones (Including simple cut solids). (9 hours)

ISOMETRIC PROJECTIONS AND VIEWS: Simple & cut solids (Prisms, Pyramids, Cones, Cylinders), Combined solids, Simple machine components. (9 hours)

ORTHOGRAPHIC CONVERSIONS: Simple & cut solids (Prisms, Pyramids, Cones, Cylinders), Combined solids, Simple machine components. (9 hours)

TEXT/ REFERENCES:

- Gopalkrishna K. R. and Sudhir Gopalkrishna (2012) "A textbook of Computer Aided Engineering Drawing", 37th Edition, Subhas Stores, Bangalore.
- Bhat N. D. and V.M. Panchal (2010) "Engineering Drawing", 50th Edition, Charotar Publishing House, Anand, India.
- Venugopal K. (2002) "Engineering Drawing and Graphics + Auto CAD" Newage International Publishers, Delhi.
- Narayana K. L. and Kannaiah P (2002) "Text book on Engineering Drawing" Scitech Publications, Chennai.
- Basant Agrawal& Agrawal C M (2010) "Engineering Drawing" Tata McGraw Hill, New Delhi.

BIOPROCESS CALCULATIONS

IBT 121 **3-1-0–4**

Introduction to Chemical & Biochemical engineering, unit operations, unit processes, importance of engineering in process design for various industries such as food processing, pharmaceutical, petrochemical and fertilizer industries. (5 hours)

Review of units and dimensions, conversion of units, physical and chemical properties of compound and mixtures; Techniques of problem solving, choosing basis, chemical equation and stoichiometry; single phase systems; ideal and real gases. (10 hours)

Vapor pressure, Raoult's and Henry's law; Bubble and dew point calculations; Humidity charts and their uses. (5 hours)

Stoichiometry of microbial growth and product formation, problems based on yield coefficients, respiration quotients, & reduction ratio. (8 hours)

Steady state material balances: Program of analysis of material balance problems; material balance for various unit operations; material balance involving multiple sub-system; material balance with chemical reactions. Material balance involving recycle, bypass and purge calculations. (12 hours)

Energy and energy balances: Balances on non-reactive process; Heat of mixing and solution; balance on reactive processes; calculations of heats of reaction; formation and combustion, adiabatic temperature. (8 hours)

TEXT/ REFERENCES:

- A. Hougen, K.M. Watson and R. A. Ragatz, Chemical Process Principles, Part – I, CBS publishers and distributors, 2nd edition, 2004.
- David M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, Eastern Economy ed., Prentice Hall of India (P) Ltd , 7th edition, 2009
- Richard Felder and Ronald W. Rausseau, Elementary principles of Chemical Processis, 3rd edition, John Wiley and Sons, 2008
- Bhat B.I. and S.M. Vora, Stoichiometry 4th edition., T.M.H. NY 2010
- Anderson and Wenzel, Introduction to Chemical Engineering, McGraw Hill, New York, 1961

BIOLOGY

IBT 122 **3–1-0–4**

Introduction to biology for engineers, Elements of Life, Explanation about the important elements in any organism, Electronegativity of the element, Importance of carbon. Different types of bonds, Some examples of different types of bonding in the biological systems, Water & phospholipid their importance in existence of life, Carbohydrates, ATP. (8 hours)

Proteins and their structures, Enzymes and how enzymes functions with one typical example, Bioenergetics, glycolysis pathway, Regulation in biochemical pathways, effect of pH, explanation about whole cell. (6 hours)

Mendelian concept of inheritance, Mendel's experiments/Mendelian genetics. Monohybrid cross, Law of segregation, Terminologies Back cross and test cross, Dihybrid cross, Law of independent assortment, Chromosomes and cell division, chromosomal theory of inheritance, Morgan's experiment, X-linked inheritance, Genetic Disorder: autosomal dominant and recessive traits. (8 hours)

Discovery of DNA - Griffith transformation experiment, Hershey chase experiment, Chargoff's rule, Structure of DNA, Meselson and Stahl experiment, Kornberg experiment, DNA replication, Mechanism of replication -proof reading and editing. (5 hours)

RNA synthesis (Transcription), process of transcription, Post transcriptional modification (RNA processing). (2 hours)

General characteristics of genetic code or triplet, Translation- initiation, elongation and termination. Problems, Post translational modifications. (2 hours)

Cell: structural and functional unit, Prokaryotic gene function: lac operon, Eukaryotic gene function: β- Globin, explanation of mutations and consequence of mutation, sickle cell anaemia, Tracing β-globin gene, Principles of Biology, Biological Hierarchies. (5 hours)

Form and Function, Modularity and incremental change, Symbiosis, coevolution, communal benefit, commensalism, Parasitism, Bioinspiration and Biomimetics. (6 hours)

Case studies: Vaccination, Concept of cloning, Recombinant DNA technology, Ascent of sap-plant water relations, Transposons, Prions, DNA finger printing. (6 hours)

TEXT/ REFERENCES:

- Life: The Science of Biology Loose Leaf, D. Sadava, D. M. Hillis, H. G. Heller, M. Berenbaum, 10th Edition (2012), W H Freeman & Co (Sd).
- 'Campbell-Biology'J.B. Reece, L.A. Urry, M.L. Cain, S.A. Wasserman, P.V. Minorsky, R.B. Jackson, Benjamin Cummings. 9th Edition (2011), Pearson Global edition.
- Biology for Engineers' By Arthur T Johnson, University of Maryland, College Park, USA Publisher: CRC Press (2010)

III SEMESTER

MATHEMATICS III

IMA 231 **3-1-0-4**

Differential equations - basic concepts and definitions, solution of exact equations, evaluation of integrating factors, solution of first order linear differential equations, Bernoulli's equation, solution by inspection, application of first order differential equations. (6 hours)

Some simple numerical methods for solutions of first order equations: Taylor series method, Euler's method, modified Euler's method, Runge-Kutta methods of order two and four. (6 hours)

Higher order linear differential equations with constant coefficients, homogeneous and nonhomogeneous differential equations, solution by the method of undermined coefficients, method of variation of parameters and inverse differential operator method. Application of second order differential equations - vibration of spring. (8 hours)

Introduction to Laplace transforms, transforms of elementary functions, periodic functions, Step functions, Dirac Delta functions, inverse transforms, convolution theorem, and solution of initial value problems by Laplace transforms method. (12 hours)

Complex variables - Analytic functions, Cauchy - Riemann equations, Harmonic functions, Line integrals, Cauchy's integral theorem, Cauchy's integral formulae. Laurent series, Residue calculus. (12 hours)

Partial differential equations - basic concepts, solutions of simple partial differential equations, method of separation of variables and indicated transforms to solve partial differential equations. (4 hours)

TEXT / REFERENCES:

- Elementary differential equations, Rainville E. D., Bedient P. E. (1989) Macmillan Publishers(Newyork).
- Advanced Engineering Mathematics - Erwin Kreyszig (2015), John Wiley & Sons.
- Introductory methods of Numerical Analysis, S. S. Sastry(2012), PHI learning Pvt. Ltd.
- Complex Variables, Murray R Spiegel and others(2015), Tata McGraw Hill(New Delhi).
- Higher Engineering Mathematics, Grewal B. S., Grewal J. S. (2015), Kanna Publishers.

BIOCHEMISTRY

IBT 231 **3–0-3–4**

Carbohydrates: Definition, Classification, general properties in reference to glucose, cyclic structure muta rotation, Haworth projections, epimers and epimerization, monosaccharides of Biological importance, monosaccharides, disaccharides- biomedical importance , important properties of monosaccharides, types of crystals, Interconversion of sugars,oxidation to produce sugar acids, reduction of sugars to form sugar alcohols, action of acids on carbohydrates. Sugar derivative of biomedical importance- deoxy sugars, amino sugars-biomedical importance, amino sugar acids, glycosides. Disaccharides, properties of disaccharides- maltose, lactose, sucrose. Invert sugars, biomedical importance of disaccharides, oligosaccharides, polysaccharides- starch, glycogen, inulin, cellulose, dextrins, dextrans. Heteropolysaccharides

classification. Acidic sulphate free MPS- Hyaluronic acid, chondroitin. Sulphate containing acid MPS-keratan sulphate, chondroitin, heparin, heparin sulphate. Neutral MPS, proteoglycans(O-glycosidic linkage, N-glycosylamine linkage). (5 hours)

Lipids:Definition, classification of lipids, simple lipids, compound lipids, derived lipids, miscellaneous- with examples. Types of fatty acids- saturated FA, unsaturated FA, branched chain FA, substituted fatty acids, cyclic fatty acids, eicosanoids. Isomerism, essential fatty acids- Biomedical importance, Alcohols, Glycerol, unsaturated alcohols, steroids and sterols. Cholesterol – forms, esterification, colour reactions. Sterols of biological importance – 1,7-dehydrocholesterol, ergosterol, coprosterol. Neutral fats –properties(chemical & physical). Lipases. Lipases. Identification of fats and oils. Phospholipids- definition , classification-phosphatidyl choline. Phospholipases, phosphatidyl ethanolamine,phosphatidyl inositol, phosphatidyl serine, plasmologens, sphingomyelins. Functions of phospholipids. Glycolipids-types of cerebrosides. Gangliosides. (6 hours)

Amino Acids and proteins:Classification of aminoacids[Non-polar amino acids, Aromatic amino acids ,Polar amino acids ,Polar uncharged amino acids, Polar amino acids with positively charged side chains , Polar amino acids with negatively charged side chains. Functions of aminoacids. Essential amino acids, selenocysteine and pyrrolysine. Properties- isomerism, amphoteric nature and isoelectric pH. Proteins- classification of proteins(on the basis of shape & size , functional properties, solubility and physical properties) Simple proteins, conjugated proteins, Derived proteins. General properties of proteins- taste, odour, molecular weight, viscosity, hydration of proteins, heat coagulation, amphoteric nature. Precipitation of proteins. Characteristics of peptide bond, Biologically important peptides. Primary structure of proteins, secondary structure [alpha helix, beta pleated sheet, reverse turn and bends], Tertiary structure, quaternary structure, prions, denaturation, purity of proteins. Structure of haemoglobin.
(6 hours)

Enzymes:Catalytic activity of enzymes, coenzymes, metalloenzymes, classification of enzymes, specificity of enzymes, Mechanism of enzyme action. Lock and key model, induced fit model Michaelis menton constant, Lineweaver burk plot. Factors affecting enzyme action. Enzyme inhibition- competitive , noncompetitive, uncompetitve, allosteric enzymes. Diagnostic applications- lipase, amylase, trypsin, cholinesterase, alkaline phosphatase, acid phosphatase,, transaminases, lactate dehydrogenase, isocitrate dehydrogenase, creatinine phosphokinase. Immobilized enzyme technology. (4 hours)

Blood:Composition, haemoglobin structure and properties, plasma proteins, Normal serum levels, clinical significance Estimations of glucose, urea, creatinine, protein, cholesterol and bilirubin. (3 hours)

Urine Chemistry: Chemical composition of urine under normal and abnormal conditions. Tests for renal function, inulin clearance, urea clearance, Renal plasma flow, composition of urine, abnormal constituents of urine, glycosuria, glucosuria, pentosuria, proteinuria, ketone bodies, bilepigments and bile salts, blood, porphyrins. (3 hours)

Hormones:General introduction, definition, major hormone secreting glands, classification Functions of hormones [protein hormones, peptide hormones, amines, steroid hormones] examples. (2 hours)

Metabolic Pathways:Introduction to metabolic pathways, Glycolysis and it regulation TCA cycle and its regulation, beta - oxidation, urea cycle, Electron transport system. (4 hours)

Bioenergetics:Biological energy transformation, concept of free energy, exergonic and endergonic reactions, coupled reactions with examples, High energy compounds [phosphoenol pyruvate, phosphocreatinine, role of high energy compounds] ATP structure and functions, Oxidative phosphorylation, Chemiosmotic hypothesis, The redox reactions [redox potential, redox couples]. (3 hours)

TEXT / REFERENCES:

- Albert L. Lehninger, David L. Nelson.,Textbook of Biochemistry, 2000.
- Textbook of Medical Biochemistry – MN Chatterjee, Rana Shinde, 7th edition Jaypee Brothers.2008.

BIOCHEMISTRY LABORATORY

1.Estimation of Sugars (1 Practical)
2. Estimation of Glucose by Different Methods (2 Practical's)
3. Extraction and Estimation of Starch (1 Practical)
4. Extraction of Protein and Estimation Different Methods (1 Practical)
5. Estimation of Cholesterol and Vitamin – C (2 Practical's)
6. Urine Analysis - Normal, Abnormal, Unknown and Estimation of Urine Creatine (3 Practical)

MICROBIOLOGY

IBT 232 **3–0-6–5**

Introduction: Microbial diversity and taxonomy, Prokaryotes and Eukaryotes, Types of Microorganisms. (2 hours)
Microbiological Techniques: Study of microscopes, Sterilization Techniques – Heat, steam, radiation, filtration and chemical. (3 hours)
Structure, Functions and Replication of Microorganisms: Bacteria, Viruses, Fungi, Algae, Protozoans, Helminths. (12 hours)
Medical Microbiology: Common diseases caused by microbes (*brief discussion*): Bacteria – Tuberculosis, Typhoid, Diarrhoea, Syphilis, Pneumonia. Viruses – Hepatitis, Polio, Rabies. Fungi – Candidiasis. Protozoans – Malaria. (3 hours)

Microbial insecticides: *Bacillus thuringinesis*, Sphaericus, Popilliae. (3 hours)

Microbial enzymes: Production of Microbial enzymes, strain, medium, fermentation processes. Large-scale application of Microbial enzymes – starch processing, textile, detergents, cheese industry. (4 hours)
Microbial polysaccharides: Examples; Xanthan: structure and applications. (2 hours)

Food industry: Microbial spoilage of food and its control; food preservatives; single cell protein (SCP) and single cell oil (SCO); food borne infections and their control. (5 hours)

Biofertilizers: Nitrogen fixing organisms. (2 hours)

TEXT / REFERENCES:

- *Pelczar*, Chan and Kreig. 1998. *Microbiology*. W C Brown Pub
- Presscot and Dunn. 2004. *Industrial Microbiology*. CBS Publishers.
- Stanier, Ingraham and Wheeler. 1994. *General Microbiology*. McMillan.

MICROBIOLOGY LAB:

In the Microbiology Lab, the following experiments will be performed.

1. Preparation of Liquid and Solid Media.
2. Pure culture Techniques - Streak, Pour and Spread Plate Methods
3. Standard Plate Count (SPC)
4. Direct Microscopic Count using a Haemocytometer
5. Simple Staining,Negative Staining, Gram Staining
6. Hot Spore Staining / Schaeffer-Fulton Method
7. Lactophenol Blue staining of Fungi
8. Indole Production Test
9. Methyl red Test
10. Voges – Proskauer Test
11. Citrate Utilization Test
12. Catalase Test
13. Triple Sugar Iron Test
14. Casein Hydrolysis
15. Determination of Quality of Milk by Methylene Blue Reduction Test.

INSTRUMENTATION AND MEASUREMENT FOR BIOLOGICALS

IBT 233 **3–0-0–3**

Introduction to Spectrometry **:**Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform Optical Measurements. (7 hours)

Molecular Spectroscopy: Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence-Instrumentation – Applications – Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications. (7 hours)

Magnetic Resonance Spectroscopy and Mass Spectrometry :Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR spectrometers – applicatons of 1H and 13C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values – instrumentation. (7 hours)

Separation Methods:General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography – Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography Affinity chromatography- principles of GC and applications – HPLC- Capillary electrophoresis – Applications. (7 hours)

Electro Analysis and Surface Microscopy: Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM. (8 hours)

TEXT / REFERENCES:

- Skoog, D.A. F. James Holler, and Stanky, R.Crouch "Instrumental Methods of Analysis". Cengage Learning , 2007.
- Willard, Hobart, etal., "Instrumental Methods of Analysis". 7th Edition, CBS, 1986.
- Braun, Robert D. " Introduction to Instrumental Analysis". Pharma Book Syndicate, 1987.
- Ewing,G.W. "Instrumental Methods of Chemical Analysis", 5th Edition, McGrawHill,1985.
- Sharma, B.K. "Instrumental Methods of Chemical Analysis : Analytical Chemistry" Goel
- Publishing House, 1972.
- Haven, Mary C., etal., "Laboratory Instrumentation ". 4th Edition, John Wiley, 1995.

TRANSPORT PROCESS - I (FLUID FLOW)

IBT 234 **3–1-0–4**

Review of fluid statics: hydrostatic equilibrium, measurement of fluid pressure: manometers and gauges. (5 hours)

Fluid dynamics: types of flow, shear stress - viscosity, classification of fluids. (3 hours)

Basic equations of fluid flow: Continuity equation & Bernoulli's equation derivation and its applications. (8 hours)

Laminar flow through non circular conduits: Reynolds number and friction factor relations for smooth and commercial pipes, Hagen Poiseulle equation – derivation and its applications. (8 hours)

Flow past immersed bodies: Boundary layer, types of drag, drag coefficient and stream lining. (4 hours)

Flow through a bed of solids: derivation of Ergun, Kozeny Carmen and Blake Plumer equation and its applications. (8 hours)

Transportation and metering of fluid flow: pipes, pipe fittings and valves, pumps and compressors, Meters: Orifice meter, Venturi meter, Pitot tube and Rotameter. (8 hours)

Agitation and mixing of liquids. (4 hours)

TEXT / REFERENCES:

- McCabe & Smith. 1993. Unit Operations of Chemical Engineering. McGraw Hill.
- Christie John Geankoplis. 2003. *Transport Processes and Separation Process Principles.* Prentice Hall; 4 edition.
- Coulson and Richardson. 2001. *Chemical Engineering - Vol. I.* ELBS
- Foust. 2008. *Principles of Unit Operations.* Wiley.

CELL AND MOLECULAR BIOLOGY

IBT 235 **3–0-0–3**

Cell division and cycle: Mitosis, Meiosis – Mechanisms and Stages, Phases of cell cycle in animals, plants and yeast, Proteins associated with cell cycle. (5 hours)

Classical Genetics: Classical experiments of Hershey and Chase, Avery McLeod and McCarty, Bacterial Conjugation, Generalized and Specialized Transduction, Transformation. (5 hours)

Structure and Organization of Nucleic Acids: Different forms of DNA and RNA – Structures and functions, Organization of DNA in Prokaryotic and Eukaryotic Chromosomes – Histones, $C_o t$ curves. (4 hours)

DNA Replication: DNA Replication in Prokaryotes and Eukaryotes, θ-mode of Replication, Displacement (D) Loops, Rolling Circle Method (σ–mode) of DNA Replication, Telomeric Replication in Eukaryotes, Replication of Viral DNA – brief overview. (5 hours)

Transcription: Transcription in Prokaryotes and Eukaryotes – Transcription Factors, Promoters, Enhancers; Post-transcriptional Modifications – RNA Splicing; Ribozymes. (5 hours)

Translation: The Genetic Code – Features, Codon and Anticodon Concept, Wobble Hypothesis, Translation in Prokaryotes and Eukaryotes, Post-translational Modifications – major points. (5 hours)

Regulation of Gene Expression: The Operon Concept – Promoter, Operator, Terminator, Attenuator, Inducer, Repressor, Effect of cAMP Complex; Few examples of operons – *lac* operon. (4 hours)

DNA Repair, Mutagenesis and Mutations: Biochemical mechanisms of DNA Repair, Types of Mutations, Biochemical basis of mutants, Modes of Mutagenesis, Reversion. (4 hours)

TEXT / REFERENCES:

- David Friefelder. 1987. *Molecular Biology*. Jones and Bartlett Publishers Inc.
- Benjamin Lewin. 2003. *Genes VII*. Oxford University Press.
- James D. Watson, Michael Gilman, Jan A. Witkowski and Mark Zoller. 1992. *Recombinant DNA Technology*. W. H. Freeman.
- James D Watson, WH Hopkins, JW Roberts, JA Steitz and AM Weiner. 2008. *Molecular Biology of the Gene*. Pearson Education Pvt Ltd

ENGINEERING ECONOMICS & MANAGEMENT

IHS 241 **3- 1 -0 -4**

ENGINEERING ECONOMICS: Introduction: Nature and significance, micro & macro differences, law of demand, and supply, elasticities & equilibrium of demand & supply. (1 hour)

Time value of money: Time value of money, interest factors for discrete compounding, nominal & effective interest rates, present and future worth of single, uniform, gradient cash flow. (4 hours)

Economic analysis of alternatives: Bases for comparison of alternatives, present worth amount, capitalized equivalent amount, annual equivalent amount, future worth amount, capital recovery with return, rate of return method, incremental approach for economic analysis of alternatives, replacement analysis. (4 hours)

Break-even and minimum cost analysis: Break even analysis for single product and multi product firms, break even analysis for evaluation of investment alternatives, minimum cost analysis. (2 hours)

Depreciation: Physical & functional depreciation, methods of depreciation - straight line, declining balance, sum-of-the-years digits, sinking fund and service output methods. (2 hours)

Financial management: Nature and objectives, scope and functions. Sources of long term finance - Characteristics of equity capital, preference capital, debenture capital & term loans. (2 hours)

Valuation of securities: Concept of valuation, bond valuation and bond valuation models, bond value theorems, yield to maturity, equity valuation; dividend capitalization approach, ratio approach. (4 hours)

Financial statement analysis: Balance sheet and profit & loss statement, meaning & contents, ratio analysis, financial ratios such as liquidity ratios, leverage ratios, turn over ratios, and profitability ratios, time series analysis, common size analysis, DuPont analysis, drawbacks of financial statement analysis. (5 hours)

MANAGEMENT: Introduction: Definition of management and systems approach, nature & scope. Functions of managers. Corporate social responsibility. (4 hours)

Planning: Types of plans, steps in planning, process of MBO, how to set objectives, strategies, policies & planning premises. Strategic planning process and tools. (6 hours)

Organizing: Nature & purpose of organising, span of management, factors determining the span, basic departmentation, line & staff concepts, functional authority, art of delegation, decentralisation of authority. (6 hours)

Staffing: HR planning, recruitment, development and training. (4 hours)

Human Factors in Managing: Theories of Motivation, special motivational Techniques. Leadership- Leadership Behaviour & styles, Managerial Grid. (6 hours)

Basic control process, Critical control points & standards, Control techniques: Budgets, non-budgetary control devices. Overall & preventive controls: Budget summaries: Profit & loss control, control through ROI, direct, preventive control. (2 hours)

TEXT / REFERENCES:

- Koontz D, "Essentials of Management", 7th edition, McGraw Hill, New York.
- Peter Drucker, "The Practice of Management", Butterworth Hein Mann, 2003.
- Thuesen G. J, "Engineering Economics", Prentice Hall of India, New Delhi, 2005.
- Blank Leland T. and Tarquin Anthony J., "Engineering Economy", McGraw Hill, Delhi, 2002.
- Prasanna Chandra, "Fundamentals of Financial Management", Tata Mc-Graw Hill Companies, New Delhi, 2005.

TRANSPORT PROCESS - II (HEAT & MASS TRANSFER)

IBT 241 **3- 1 -0 -4**

Different modes of heat transfer, Conduction- Fourier's law, application for plane, cylinder and sphere, variation of thermal conductivity, heat flow through multilayer systems, conduction with heat generation, biological heat production-microbial system. (9 hours)

Convection-Natural and forced convection, concurrent and countercurrent types of flows, LMTD, Overall heat transfer coefficient, dimensional analysis, Heat exchangers (basic functioning) – Double Pipe Heat Exchanger and Shell and Tube Heat Exchanger. (10 hours)

Heat Transfer with phase change- theories of Boiling and Condensation, evaporator (basic functioning) and types. (6 hours)

Radiation-Black body radiation, Kirchoff's law and Stefan Boltzman's law, applications. (4 hours)

Diffusion in fluids-Molecular and Eddy diffusion in gases and liquids-Fick's law, steady state diffusion under stagnant and equimolal flow conditions, diffusivity estimation. (7 hours)

Mass Transfer concept-Driving Force, mass transfer under laminar and turbulent past solids, Two film theory, Mass Transfer coefficient, overall mass transfer coefficient, J_D,HTU and NTU, Different theories of Mass Transfer. (9 hours)

Analogies between heat and mass transfer, various dimensionless numbers and their significance. (3 hours)

TEXT / REFERENCES:

- J. P. Holman, "Heat Transfer", McGraw Hill, 2005
- Pauline M. Doran, "Bioprocess Engineering Principles", Academic Press, 1995
- Robert E. Treybal, "Mass Transfer Operations", McGraw-Hill, 1980
- McCabe and Smith, "Unit Operations of Chemical Engineering", McGraw Hill
- Publications, 1993

BIO-ORGANIC CHEMISTRY

IBT 242 **3- 0 -0 -3**

Isomerism: Definition, Classification- Structural and stereo isomerism, structural isomerism position, functional, chain and ring chain isomerism, metamerism and tautomerism, geometrical isomerism cis & trans, syn & anti forms- Geometrical isomerism in cyclic (3,4,5,6 membered rings) compounds. (3 hours)

Optical isomerism: Conditions for optical activity, Optical isomerism in lactic acid and tartaric acids, resolution of racemic mixture, conformations and stability of cyclohexane and its derivations, 1-2,1-3 and 1-4 disubstituated cyclohexanes. (3 hours)

Strength of organic acids and organic bases- bronsted theory and lewis concepts, conjugated pair, factors affecting the strength of acids, effect of structure, H bonds, steric effect, effect of solvent, pKa value, aliphatic carboxylic acids mono & dicarboxylic acids, substituted carboxylic acids, aromatic acids, phenols substituted phenols. (5 hours)

Organic bases pKb value, aliphatic bases primary, secondary & tertiary bases, aromatic bases and heterocyclic bases. (4 hours)

Reaction intermediates: Homolysis and heterolysis, free radicals, carbonium ions, carbanions, carbenes, stability due to resonance, hyperconjugation, inductive effect, rearrangement with carbocations, Reactions involving these. (4 hours)

Active methylene group compounds, acetoacetic and malonic ester preparation and synthetic applications, diethyl malaonate, preparation, applications, diazomethane preparation and synthetic applications. (3 hours)

Amino acids: classification, essential amino acids, synthesis of amino acids, general physical and chemical properties of amino acids, iso electric point, electrophoresis, peptides and polypetides, classification, importance in the body system, methods of synthesis. (6 hours)

Proteins: classification, general properties, color tests, structure of proteins.
Heterocyclic compounds: Classification and examples, aromaticity and basicity of heterocyclic compounds. Five membered heterocyclic compounds pyrrole preparation and properties, six numbered heterocycles pyridine preparation & properties. Fused ring heterocycles quinolone preparation and properties. (4 hours)

Aromatic compounds: Structure of benzene, electrophilic substitution- mechanism of nitration, halogenation, sulphonation, fridel-crafts reaction, orientation in monosubstituted derivations. (4 hours)

TEXT / REFERENCES:

- Organic chemistry, vol.1 by I.L.Finar.
- Organic Chemistry, by Morrison & Boyd.
- Advanced Organic Chemistry by B.S. Bahl & Arum Bahl.

FOUNDATIONS IN COMPUTATIONAL BIOLOGY

IBT 243 **3- 0 -6 -5**

Introduction:The flow of genetic information, Nucleic acids – DNA, RNA, Genetic code, Transcription, Translation and Protein Synthesis, Junk DNA and Reading Frames, Chromosomes, Genome & Computer Program, The Human Genome Project and the Digital code of Life, Applications of Bioinformatics. (6 hours)

Biological Databanks:Sequence Databases: Introduction, Primary and secondary databases, Nucleotide and protein sequence databases. Information retrieval from Biological databases, Retrieving Database Entries: Integrated Information Retrieval, The SRS & Entrez System, Structure databases: Introduction to Structures, Protein Data Bank (PDB), Molecular Modeling Database (MMDB) at NCBI. (6 hours)

Algorithms: Introduction, The evolutionary basis of sequence alignment, the Modular Nature of proteins, Optional Alignment Methods, Database Similarity Searches: BLAST, FASTA, Low-Complexity Regions, Repetitive Elements. Pairwise sequence alignment - NEEDLEMAN and Wunsch, Smith-Waterman algorithm; Multiple sequence alignments – CLUSTAL, Motifs and Patterns, Primer design. (8 hours)

Structural computing: Anatomy of Proteins - Secondary structures, Motifs, Domains, Tertiary and quaternary structures- Ramachandran plot; Structure file formats, visualizing structural information, structure viewers; RNA structure; Structure of Ribosome; RNA Secondary Structure Prediction, Structure of small molecules. Introduction to Set theory, Graph theory, Strings & Algorithms, Chemical graphs. (8 hours)

Evolutionary computing: Tree of life project, Elements of phylogenetic Models, Phylogenetic Data Analysis, Substitution Model Building, Tree Building, and Tree Evaluation, Building the Data Model (Alignment), Determining the Substitution Model, Tree -Building Methods, Searching for Trees, Rooting Trees, Evaluating Trees and Data, Phylogenetic software on the web. (8 hours)

TEXT / REFERENCES:

- BIOINFORMATICS: Sequence and Genome Analysis by David W Mount, Cold Spring Harbor, 2001.
- Introduction to Bioinformatics by Arthur M. Lesk, Oxford University Press, 2002.
- Computational methods in Molecular Biology. S.L.Salzberg, D B Searls, S Kasif eds, Elsevier, 1998.
- Introduction to Computational Molecular Biology, J. Setubal and J. Meidanis, PWS Publ. 1997.
- Computational Methods in Molecular Biology, S. Salzberg, D. Searls, and S. Kasif eds., Elsevier, 1998.
- Bioinformatics, A. Baxevanis and B. Ouellette, Wiley Inter-science, 1998.

FOUNDATIONS IN COMPUTATIONAL BIOLOGY LABORATORY

1. Retrieving a Nucleotide / Protein sequence
2. Similarity Search: FASTA and BLAST
3. Sequence Alignment
4. Basics of PERL Programming
5. Primer Design
6. Secondary Structure Prediction of Proteins
7. Structure Visualization & Analysis
8. Structure Alignment
9. Protein Modeling
10. Phylogenetic Analysis

GENETIC ENGINEERING

IBT 244 **3- 0 -3 -4**

Basics of Recombinant DNA Technology: Manipulation of DNA – Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for yeast, insect and mammalian systems, Prokaryotic and eukaryotic expression host systems, Introduction of recombinant DNA in to host cells and selection methods. (8 hours)

DNA Libraries :Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Chromosome walking, Screening of DNA libraries using nucleic acid probes and antisera. (5 hours)

Sequencing and Amplification of DNA: Maxam Gilbert's and Sanger Coulson's and automated methods of DNA sequencing, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons, Site directed mutagenesis. (7 hours)

Techniques in Genetic Engineering: Organization and structure of genomes, Genome sequencing methods, Conventional and shotgun genome sequencing methods, Next generation sequencing technologies, Ordering the genome sequence, Genetic maps and Physical maps, STS content based mapping, Restriction Enzyme Finger Printing, Hybridization mapping, Radiation Hybrid Maps, Optical mapping. ORF finding and functional annotation. (9 hours)

Techniques in Genomic analysis: Current status of genome sequencing projects, Introduction to Functional genomics, Microarrays, Serial Analysis of Gene expression (SAGE), Subtractive hybridization, DIGE, TOGA, Yeast Two hybrid System, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics. (7 hours)

TEXT / REFERENCES:

- Primrose SB and R. Twyman "Principles Of Gene Manipulation & Geneomics Blackwell Science Publications, 2006.
- Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, Third Edition (Blackwell Publishing), 2003.

- Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols In Molecular Biology
- "Greene Publishing Associates, NY, 1988.
- Berger Sl, Kimmer AR, "Methods In Enzymology", Vol 152, Academic Press, 1987.
- Genomes 3 by T.A.Brown, Third Edition (Garland Science Publishing), 2007.

BIOLOGICAL THERMODYNAMICS

IBT 245 **3- 0 -0 -3**

Introduction: Scope and definition of Thermodynamics, zeroth law, Internal Energy, First law of Thermodynamics, Thermodynamic state and state functions, Equilibrium, phase rule, reversible processes, Energy balance for closed & continuous systems. Enthalpy and heat capacities, Ideal gas equation, Constant volume, constant pressure, isothermal & adiabatic process. Cubic equations (8 hours)

Second law of thermodynamics : Statements of second law, heat engine, carnot cycle, Thermodynamic temperature scale, entropy,Entropy change of ideal gas, Mathematical statement of second law, Third Law of Thermodynamics. (5 hours)

Thermodynamic properties of fluids: Property relations for homogenous phases, importance of Gibb's free energy. (1 hour)

Solution thermodynamics : Chemical potential and Phase Equilibria, Partial properties, Ideal Gas Mixtures, Fugacity and Fugacity Coefficients, Activity and Activity Coefficients, Property changes of Mixing, PVT behaviour of pure substances, two phase systems, Clausius-Clapeyron Equation. (8 hours)

Chemical reaction equilibrium: Reaction Co-ordinate, Application of equilibrium criteria to chemical reactions, Standard Gibb's Energy change and Equilibrium constant, Relation of equilibrium constant, Effect of Temperature on Equilibrium constants, Equilibrium conversions for single phase reactions. (6 hours)

Biochemical thermodynamics: Free energy calculation- Biochemical example (isomerisation of Glucose 6 phosphate to fructose 6 phosphate), High energy phosphate compounds as energy shuttlers, phosphate transfer and coupled reactions, Blood and entropy, Carbon monoxide poisoning , Protein stability, osmosis, dialysis, Diffusion, membrane transport. (8 hours)

TEXT / REFERENCES:

- Introduction to Chemical Engineering Thermodynamics, J.M.Smith, H.C.Van Ness and M.M.Abbott, McGraw Hill International Edition
- Biological Thermodynamics, Donald T. Haynie, Cambridge University Press
- Physical chemistry, Silbey, Alberty, Bawendi, Wiley India, fourth edition

V SEMESTER

PROJECT WORK

IBT 351 **0-0-36-12**

Students need to form batches with maximum four in numbers and required to identify the problem in their area of interest within their discipline of study under the supervision of a faculty (Guide) for 12 to 14 weeks. At the end, the findings need to be presented in the form of a project report for final evaluation.

VI SEMESTER

BIOPROCESS ENGINEERING

IBT 361 **3-1-0-4**

Introduction to Enzymes and Enzyme catalyzed reactions: Nature and function of enzymes, coenzyme and cofactor, classification of enzymes. Michaelis-Menten Equation – mechanism, derivations, types of enzyme inhibition, kinetics, effect of environmental factors on enzyme activity. (10 hours)

Introduction to Fermentation Processes: Definition of Fermentation, history of Industrial fermentation, the basics of Industrial fermentation, fermentation products. (2 hours)

Media Design and Sterilization: Medium requirements for fermentation processes- Carbon, nitrogen, minerals, vitamins and other complex nutrients; oxygen requirements; Medium formulation for optimal growth and product formation- examples of simple and complex media; Design and usage of various commercial media for industrial fermentations. Thermal death kinetics of microorganisms; Batch and continuous heat -Sterilization of Liquid media; Filter sterilization of liquid media, Design of Sterilization Equipments. (12 hours)

Transport Phenomena in Bioreactors:Immobilization methods; Immobilized enzyme/cell kinetics: Shell balance – zero & first order reactions, spherical & flat plate mode, effectiveness factor derivations (internal & external), mass transfer correlations. Bioprocess considerations in using animal and plant cell cultures. Oxygen transfer in submerged fermentation processes: OTR, OUR calculations, k_La estimations; role of aeration and agitation in oxygen transfer. (12 hours)

Kinetics of Microbial Growth and Product Formation: Effect of environmental factors on microorganism growth. Cell Growth Measurements, Growth Cycle for Batch cultivation, Microbial cell kinetics. Simple unstructured kinetic models for microbial growth; Monod model; Growth of Filamentous Organisms. Growth associated (primary) and non-growth associated (secondary) product formation kinetics; Leudeking Piret models; substrate and product inhibition on cell growth and product formation. (12 hours)

TEXT / REFERENCES:

- Michael L Shuler and Fikret Kargi. 2008. Bioprocess Engineering: Basic Concepts. Prentice-Hall of India Pvt Ltd.
- Pauline M. Doran. 1995. Bioprocess Engineering Principles. Academic Press.
- "Principles of Fermentation Technology" by PF Stanbury, S. Hall, A. Whitaker, 2nd Edition, Elsevier Science Publishers, 2003
- Levenspiel, O. 1972. Chemical Reaction Engineering. John Wiley.

SEPARATION TECHNIQUES IN BIOTECHNOLOGY

IBT 362 4-0-3-5

Role and importance of downstream processing in biotechnological processes. Problems and requirements of bioproduct purification, physicochemical basis of bio-separation processes. (4 hours)

Cell disruption: Physical methods- Osmotic shock, grinding with abrasive solid shear, liquid shear, chemical methods-alkali reagents, enzymatic methods. Different methods of cell disruption –Advantages & Disadvantages. (4 hours)

Removal of insoluble, biomass (and particulate debris) separation: sedimentation, centrifugation and filtration methods. (8 hours)

Membrane – based separations (Micro- and Ultra-filtration) theory; design and configuration of membrane separation equipment; applications. (6 hours)

Precipitation methods with salts, organic solvents, and polymers; colloidal stability of protein solutions; kinetics of protein aggregation. (4 hours)

Extraction: batch extractions, staged extractions-cross current, co current, counter current extractions. Aqueous two-phase extraction, reverse micelle extraction, supercritical fluid extraction. (6 hours)

Theories of adsorption – Adsorption isotherms, industrial adsorbents, adsorption equipments for batch and continuous operations (co current and counter current), adsorption in fixed beds. (6 hours)

Chromatography – principles of chromatographic separation – gel filtration, reversed phase, hydrophobic interaction, ion-exchange, expanded bed adsorption, bio affinity and IMAC, chromatography. (4 hours)

Electrophoretic separations (all electrophoresis techniques, including capillary electrophoresis), Isoelectric focusing. (3 hours)

Crystallization: Factors governing nucleation and crystal growth. Theory of crystallization. batch and continuous crystallizers. (3 hours)

TEXT / REFERENCES:

- Bioseperations: Principles and Techniques by B.Sivasankar, PHI Learning Pvt. Ltd., 2006
- Bioseparation – Downstream processing for biotechnology by Belter P.A., Cussler E. and Wei Shan Hu., Wiley Interscience Pub, 1988.
- Separation Processes in Biotechnology by Asenjo J. and Dekker M, 1993.
- Product Recovery in Bioprocess Technology - BIOTOL Series, VCH, 1990

SEPARATION TECHNIQUES IN BIOTECHNOLOGY LABORATORY

List of Experiments

1. Aqueous Two Phase Systems – Binodal Curve
2. Partitioning of proteins in Aqueous Two Phase Systems
3. Cell Disruption by Ultra Sonication
4. Cell Disruption by Enzymatic Digestion
5. Leaf Filter
6. Ultrafiltration
7. Batch Sedimentation
8. Ammonium Sulphate Precipitation
9. Thin Layer Chromatography
10. Size Exclusion Chromatography

ELECTIVE – I

IBT 363 **3-0-0-3**

GENOMICS AND PROTEOMICS:

Introduction: Genes and Proteins, Genomics and proteomics, unicellular genomes, Metazoan Genomes, Typical human Gene, Evolution of Genomes. (4 hours)

Sequencing & Genome Projects: Early sequencing efforts. Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods, Sanger Dideoxy method, Fluorescence method, shot-gun approach, Next Generation Sequencing, Human genome diversity project. (6 hours)

Genomics: Raw genome sequence data, expressed sequenced tags (ESTs), Gene variation and Single Nucleotide Polymorphisms (SNPs), disease association, diagnostic genes and drug targets, genotyping -DNA Chips, Comparative genomics. Studies with model systems such as Drosophila, Yeast or *C. elegans*. (6 hours)

Proteomics: Methods of protein isolation, purification and quantification. Large scale synthesis of proteins, use of peptides in biology, analysis of proteins, high throughput screening, engineering novel proteins. Peptidomimetics, Bioinformatics analysis -clustering Methods, proteome functional information, two hybrid interaction screens, Mass-spec based protein expression and post translational modification analysis, "Protein Chip" interaction detection. (8 hours)

Genome Management in Eukaryotes: Multicellularity, cell differentiation and gene regulation. Inheritance pattern in eukaryotes. Mutations, organization of eukaryotic genome within the nucleus, eukaryotic transcription units, regulation of transcription, transcription factors and the co-ordination of gene expression, translation and post-translational modification in eukaryotes, mitochondrial and chloroplast genome. (8 hours)

Bioinformatics and Functional Genomics: Bioinformatics Approaches to Gene Expression, Microarray data analysis, Completed Archea, Bacterial and Viral genomes. Human genome and disease identification, OMIM, Comparative genomics. (4 hours)

TEXT / REFERENCES:

- John R S Finchman. 1994. Genetic Analysis - Principles, Scope and Objectives. Blackwell Science.
- A.Malcolm Campbell and Laurie J.Heyer.2006. Discovering Genomics, Proteomics and Bioinformatics. Pearson.

BIOREMEDIATION:

Introduction to Bioremediation: Sources of contamination; Current remediation practices; Advantages and disadvantages of bioremediation; Factors influencing Bioremediation; Global Application of Bioremediation Technologies. (7 hours)

Microbial ecology and metabolism: Factors influencing Growth and Biodegradation-Modelling Growth and Biodegradation; Oxidation and Reduction reactions; Metabolism of Organic Material; Metabolism of Inorganic material; Phototrophic Metabolism; Cometabolism. (6 hours)

Mechanisms of Biodegradation: Biodegradation of Hydrocarbons; Biodegradation of Halogenated Aliphatic and Aromatic compounds. (5 hours)

Bioremediation processes: In-situ Treatment: In situ Remediation of Aquifers and Soils; Solid Phase Bioremediation: Land Treatment and Composting; Slurry-Phase Bioremediation: Process description, Reactor configurations, Design considerations, Operating parameters and Process control; Vapor phase Bioremediation: Biofilters and Biotrickling filters. (6 hours)

Biotreatment of Metals: Microbial Transformation of Metals; Biological Treatment Technologies for Metals Remediation; Bioleaching. (6 hours)

Phytoremediation: Phytoremediation of organic, metals and inorganic contaminants: Phytoextraction, Rhizofiltration, Phytostabilization; Few Case Studies. (6 hours)

TEXT / REFERENCES:

- Eweis, Ergas, Chang and Schroeder. 1998. Bioremediation Principles. McGraw-Hill Series in Water Resources and Environmental Engineering.
- Martin Alexander. 1999. Biodegradation and Bioremediation. Academic press.
- John. T. Cookson, Jr. 1995. Bioremediation engineering; design and application. Mc Graw Hill, Inc.

FOOD PROCESSING TECHNOLOGY:

Introduction to Food Processing: Biotechnology in relation to the food industry; nutritive value of food; types of microorganisms associated with food - their sources, types and behavior. (6 hours)

Food Spoilage & Preservation: Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry and Seafood. Spoilage of miscellaneous Foods, Food-borne illnesses. (6 hours)

Food Preservation : Rheology of Food Production, Food Preservation Using Irradiation, Characteristics of Radiations of Interest in Food Preservation., Principles Underlying the Destruction of Microorganisms by Irradiation, Processing of Foods for Irradiation, Application of Radiation. Legal Status of Food Irradiation, Effect of Irradiation of Food constituents; Food

Preservation with Low Temperatures, Food Preservation with High Temperatures, Preservation of Foods by Drying. (8 hours)

Biotechnology in Food Industry: Characteristics of Food Industry. Food manufacturing & processing, common additives, bioorganic additives, spoilage, prevention of spoilage, storage and preservation through biotechnological means, food packaging. Factors influencing food product development, marketing, and promotional strategies. (6 hours)

Food Industry: Basal metabolic rate, influences on nutritional status, dietary strategies for individuals, diet for specific groups, Market Place, ecologically sustainable production, risks and benefits of biotechnology to food industry. (4 hours)

Applied Unit Operations in Food Processing: Unit operations applied to the food processing industry – Fluid flow applications, Heat transfer applications, Centrifugation, Filtration, Extraction, Membrane separations, Evaporation, Distillation, Absorption, Size reduction, Mixing, Drying, and Crystallization. (6 hours)

TEXT / REFERENCES:

- Roger, A., Gordon, B. and John, T. 1989. Food Biotechnology. Cambridge University Press
- James Jay. 1992. Modern food Microbiology. Kluwer Academic Publishers.
- W Lindsay. 1988. Biotechnology – Challenges for the flavor and food industry. Elsevier Applied Science.
- Earle, R. L. 1983. Unit operations in food processing. Pergamon Press.

ELECTIVE – II

IBT 364 **3-0-0-3**

BIONANOTECHNOLOGY:

Introduction and the scope of Bionanotechnology, Comparison of Biotechnology to Bionanotechnology. (2 hours)

Bionanomachines and their Basics: Negligible gravity and inertia, atomic granularity, thermal motion, water environment and their importance in bionanomachines, The role of proteins, amino acids, nucleic acids, lipids and polysaccharides in modern biomaterials. Overview of natural Bionanomachines: Thymidylate Sythetase , ATP synthetase, Actin and myosin, Opsin, Antibodies and Collagen. (3 hours)

Synthesis of Biomolecules: Recombinant Technology, Site-directed mutagenesis, Fusion Proteins. Quantum Dot structures and their integration with biological structures. Tools of Analysis: X-Ray crystallography, NMR spectroscopy, Electron microscopy and Atomic force microscopy. Molecular modeling tools: Graphic visualization, structure and functional prediction, Protein folding prediction and the homology modeling, Docking simulation and Computer assisted molecular design. (6 hours)

Structural principles of Bionanotechnology raw matertials: Factors governing biomolecular structure and stability, Protein folding; Self assembly, Self-organization, Molecular recognition and Flexibility of biomaterials. (5 hours)

Functional principles of Bionanotechnology: Information driven nanoassembly, Energetics, Role of enzymes in chemical transformation, allosteric motion and covalent modification in

protein activity regulation, Structure and functional properties of Biomaterials, Bimolecular motors: ATP Synthetase and flagellar motors, Traffic across membranes: Potassium channels, ABC Transporters and Bactreriorhodapsin, Bimolecular sensing, Self replication, Machine-Phase Bionanotechnology. (10 hours)

Fields of Application: Designer proteins, Peptide nucleic acids, Nanomedicine, Drug delivery, DNA computing, Molecular design using biological selection, Harnessing molecular motors, Artificial life, Hybrid materials, Biosensors, Future of Bionanotechnology.

(10 hours)

TEXT / REFERENCES:

- David S Goodsell , Bionanotechnology, John Wiley & Sons, 2004.
- Greco Ralph S , Nanoscale Technology in Biological Systems, CRC Press, 2005.

ANIMAL AND PLANT BIOTECHNOLOGY:

Plant Genome Organization: Organization and features of mitochondrial, nuclear and choloroplast genome – Structural features of gene families in plants. (3 hours)

Plant cell cultivation: Biochemistry of major metabolic pathways, Autotrophic and heterotrophic growth, Plant growth regulators and elicitors, Totipotency, Regeneration of plants Cell suspension culture development: methodology, kinetics of growth and product formation, nutrient optimization, Plant products of industrial importance, Production of secondary metabolites by plant suspension cultures. (8 hours)

Techniques in raising transgencies and IPR: Direct and indirect methods: Mechanical, Femptosyringe, electroporation, biolistic, Chemical: Protoplast, Biological: Agrobacterium mediated plant transformation, chloroplast transformation, in-planta transformation.

(3 hours)

Animal Cell Organization and nutrient requirement: Special features and organization of animal cells, Animal cell metabolism, Animal cell growth characteristics, Principles of sterile techniques, Regulation and nutritional requirements for mass cultivation of animal cell cultures.

(6 hours)

Animal cell cultivation: Substrate and product transport through mammalian cell, Animal cell growth kinetics and shear force. Micro and Macro carrier attached growth, Cell culture in continuous, perfusion and hollow-fiber reactor, Disposable bioreactors. (5 hours)

Techniques in animal biotechnology: Hybridioma technology, Live stock improvement, Gene transfer methods in animals, Transgenic animals, Applications of Cloning and xenotransplantation, Animal cell preservation. (5 hours)

Intellectual Property Rights: Introduction and history, Protection of intellectual property rights, Patent laws and procedure of patenting, Limits of a patent, Plant variety protection.

(6 hours)

TEXT / REFERENCES:

- R.A. Dixon and Gonzales. Plant Cell Culture: A Practical Approach. IRL Press.
- K. Lindsey and M.G.K. Jones. 1990. Plant Biotechnology in Agriculture, Prentice Hall.
- BIOTOL Series. 1994. Invitro Cultivation of Plant cell, Butterworth Heinemann Ltd.
- BIOTOL Series. 1994. Invitro Cultivation of Animal cell. Butterworth Heinemann Ltd.

- R. Ian Freshney .2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized . Wiley and Sons.
- M. M. Ranga. 2007. Animal Biotechnology. Agrobios.
- Bhojwani&Rajdhan. Animal and Plant Biotechnology. Elsevier Science Ltd.

IMMUNOTECHNOLOGY:

The Immune System: Introduction to innate and adaptive immunity; Lymphocytes – their origin and differentiation; Antigens – their structure and classification; Complement and their biological functions; Types of immune responses; Blood typing. (5 hours)

Humoral Immunity: B-lymphocytes: Classification and activation; Immunoglobulins: Structure, function, classes and subclasses; Genetic control of antibody production; Idiotypes and idiotypic antibodies; Major histocompatibility complex. (5 hours)

Cellular Immunity: Thymus-derived lymphocytes (T-cells): Classification and activation, Antigen presenting cells – macrophages, dendritic cells and Langerhans cells - Origin, activation and functions; Mechanisms of phagocytosis; Immunosuppression and Immune tolerance. (5 hours)

Antigen-Antibody interactions: Precipitation, agglutination, neutralization. Immunological and antibody-based assays: RIA, ELISA, Chemiluminescence, ELIspot, FACS, Western blotting, Immunofluorescence, immunoprecipitation, immunodiffusion, immunoelectrophoresis. (8 hours)

Autoimmunity: Auto antibodies in humans, pathogenic mechanisms, Treatment of auto immune disorders. (4 hours)

Molecular Immunology: Preparation of vaccines, application of rDNA technology to production of antibodies. (5 hours)

Recent Advances: Stem cells and applications to immunology; Monoclonal antibodies and diagnosis; Immunosuppressive drugs; Mechanisms of immunity to tumor antigens. (4 hours)

TEXT / REFERENCES:

- Roitt I. 1991.*Essential Immunology*.Blackwell Scientific Publications.
- Richard Goldsby, Thomas J. Kindt, Barbara A. Osborne. 2006. *Kuby Immunology*. WH Freeman.

ELECTIVE – III

IBT 365 **3-0-0-3**

MOLECULAR MODELING AND DRUG DESIGN:

Introduction: Drug Design: Receptor-based and ligand-based, General concepts of Pharmacology, Biological membranes, Penetration of membranes by organic molecules, Drug targets, Drug stability, solubility and bioavailability. (6 hours)

Drug Structure: Drug definition, Chemoinformatics/Cheminformatics, Conceptual convergence of biology and chemistry through informatics, Molecular similarity, dissimilarity and diversity,

Chemical Graphs, 1D search – Simplified Molecular Input Line Entry Specification (SMILES), Molecular Descriptors, Lead-likeness, Drug-likeness, Drugability assessment. (10 hours)
Molecular Modeling: Molecular Orbital theory. Small molecular modeling, 1D, 2D and 3D analyses, Pharmacophore, Quantitative Structure Activity Relationships (QSAR), Agonists and Antagonists, Affinity (Binding) assays, Forces related to Drug Binding and Solvation. (10 hours)
Molecular modeling in drug discovery, De novo ligand design, Similarity search - Virtual screening, Molecular docking – Structure Based methods to identify lead components, Synthetic considerations, Combinatorial synthesis, Adverse effects, Toxicology, Clinical trials, Regulatory affairs & Patenting. (10 hours)

TEXT / REFERENCES:

- A.R.Leach. 2001.Molecular Modelling Principles and Applications.Longman.
- Kenneth M. Merz, Jr, Dagmar Ringe, Charles H. Reynolds (Eds.). 2010. Drug Design: Structure- and Ligand-Based Approaches. Cambridge University Press.

BIOPHARMACEUTICAL ENGINEERING:

Introduction to Biopharmaceutics and Pharmacokinetics: Biopharmaceutics, Measurement of Drug Concentrations, Plasma Level–Time Curve, Basic Pharmacokinetics and Pharmacokinetic Models. Mathematical Fundamentals in Pharmacokinetics. (3 hours)

Physiologic Factors Related to Drug Absorption: Common Routes of Drug Administration, Advantages & disadvantages, Nature of Cell Membranes, Passage of Drugs Across Cell Membranes, Carrier-Mediated Transport, Drug Absorption in the Gastrointestinal Tract. (5 hours)
One-Compartment Open Model: Intravenous Bolus Administration, Apparent Volume of Distribution, Drug Clearance in the One-Compartment Model, One-Compartment Model Equation in Terms of Cl and V_D , Clearance from Drug-Eliminating Tissues, Calculation of K from Urinary Excretion Data, Problems in Obtaining Valid Urinary Excretion Data. (5 hours)
Multicompartment Models: Intravenous Bolus Administration, Two-Compartment Open Model, Method of Residuals to determine rate constants, Apparent Volume of Distribution at Steady State, Significance of the Volumes of Distribution, Determination of Compartment Models. (6 hours)
Intravenous Infusion: One-Compartment Model Drugs, Steady-State Drug Concentration (C_{SS}) and Time Needed to Reach C_{SS} , Loading Dose Plus IV Infusion, Intravenous Infusion of Two-Compartment Model Drugs. (6 hours)

Pharmacokinetics of oral Absorption: Zero-Order Absorption Model, First-Order Absorption Model, Method of Residuals, Determination of k_a by Plotting Percent of Drug Unabsorbed versus Time, Estimation of k_a from Urinary Data, Determination of k_a from Two-Compartment Oral Absorption Data. (6 hours)

Bioavailability and Bioequivalence: Definitions, Purpose of Bioavailability Studies, Relative and Absolute Availability, Methods for Assessing Bioavailability, Bioequivalence Studies, Drug Products with Possible Bioavailability and Bioequivalence Problems, Design and Evaluation of Bioequivalence Studies. (5 hours)

TEXT / REFERENCES:

- Rosenbaum S.E.: Basic Pharmacokinetics and Pharmacodynamics. An Integrated Textbook and Computer Simulations. John Wiley&Sons, Inc., 2011.
- Shargel L. Wu-Pong S., Yu A.B.C. Applied biopharmaceutics & pharmacokinetics. McGraw Hill 2005.
- Burton M.E., Shaw L.M., Schentag J.J., Wiliams W.E.: Aplied Pharmacokinetics &Pharmacodynamics. Lippincott Williams & Wilkins, 4th edition, 2006.
- Tozer T.N., Rowland M.: Introduction to pharmacokinetics and pharmacodynamics.The Quantitative basis of drug therapy. Lippincott Williams & Wilkins, 2006.
- Winter M.E: Basic Clinical Pharmacokinetics. Lippincott Williams&Wilkins 4th edition, 2003.

ELECTIVE – IV

IBT 366 **3-0-0-3**

METABOLIC ENGINEERING:

Introduction: Jacob Monod model, catabolite regulation, glucose effect, cAMP deficiency, feedback regulation, regulation in branched pathways, differential regulation by isoenzyme, concerted feedback regulation, cumulative feedback regulation, amino acid regulation of RNA synthesis, energy charge, regulation, amino acid regulation of RNA synthesis, energy charge, regulation, permeability control passive diffusion, active transport group transportation.

(10 hours)

Synthesis of Primary Metabolites: Alteration of feedback regulation, limiting accumulation of end products, feedback, resistant mutants, alteration of permeability, metabolites. (4 hours)

Biosynthesis of Secondary Metabolites: Precursor effects, prophophase, idiophase relationship, enzyme induction, feedback regulation, catabolite regulation by passing control of secondary metabolism, producers of secondary metabolites. (8 hours)

Bioconversions: Advantages of Bioconversions, specificity, yields, factors important to bioconversion, regulation of enzyme synthesis, mutation, permeability, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances. (8 hours)

Regulation of Enzyme Production: Strain selection, improving fermentation, recognizing growth cycle peak, induction, feedback repression, catabolite repression, mutants resistant to repression, gene dosage. (6 hours)

TEXT / REFERENCES:

- Gregory N. Stephanopoulos., Aristos A. Aristidou., Jens Nielsen., "Metabolic Engineering: Principles and Methodologies", Academic press, 1998
- Wang D.I.C., Cooney C.L., Demain A.L., Dunnil.P., Humphery A.E., Lilly M.D, "Fermentation and Enzyme Technology", John Wiley and Sons, 1979
- Stanbury P.F., Whitaker A, "Principles of Fermentation Technology", Butterworth-Heinemann, 1999

PROTEIN ENGINEERING:

Introduction: Evolution of DNA and proteins, Classification of Protein topologies, Helices and sheets, Helix-coil theory, β- buldge and β- barrels, short β- hairpins, β- sheet proteins, α + β proteins, α / β proteins, β-α-β unit (linear or open and closed), TIM and other barrel structures, conformation of polypeptides and side chains. (10 hours)

Protein folding: The Protein folding energy landscape, molten globules, enzymes and folding pathways, Evolution of globins, serine proteinases, NAD binding domains of dehydrogenases, Hinge motions in proteins-lactoferrin/myosin, The 'helix interface shear' mechanism, SERPINs, Protein misfolding and β -Amyloid Formation. (10 hours)

Protein engineering: Basic outline of protein engg, challenges and importance, protein design principles and methods, molecular recognition by combinatorial and rational approaches, tagged cell surface receptors for drug discovery, Stabilization of industrial enzymes by protein engineering, Engineering β -glycoside hydrolases, engineering specificity and stability in glucoamylase from Aspergillus niger, Designer pectins, Protein engineering in Biosensors, Vaccine development and other recent advances. (16 hours)

TEXT / REFERENCES:

- Lesk A.M. 2003. Introduction to Protein Architecture. Oxford Univ Press.
- Branden C, Tooze R. 1993. Introduction of Protein structure. Garland.
- Alberghina L (Ed) 2005. Protein Engineering in Industrial Biotechnology, Harwood academic publishers.
- Victor M (Ed) 2008. Protein Folding, Misfolding and Aggregation: Classic Themes and Novel Approaches, RSC publishers.

SEMINAR

IBT 367 **0-0-3-1**

Students need to present a seminar on a topic of recent developments in their subject filed.

B.Sc. (BIOMEDICAL)

II SEMESTER

ELEMENTS OF ELECTRICAL AND ELECTRONICS ENGINEERING

IEE 121 **3-1-0-4**

Review of DC circuit analysis, network reduction techniques. (2 hours)

Single-phase AC Circuits: Alternating voltages and currents, generation of single phase alternating voltage, average value and RMS value of periodic sinusoidal and non- sinusoidal wave forms, form factor. (3 hours)

Representation of time-varying quantities as Phasors; j Operator; Representation of Phasor in polar, rectangular and exponential forms. (2 hours)

Basic AC circuits: sinusoidal alternating current in a pure resistor, pure inductor and a pure capacitor, waveforms of voltage, current, and power, Phasor diagram, inductive and capacitive reactances.
Steady-state analysis of RL, RC, and RLC series circuits: concept of impedance and Phasor diagram, expression for average power, power factor. Parallel AC circuits: admittance, conductance, susceptance. Analysis of series parallel circuits, Phasor diagrams, active power, reactive power and apparent power, complex power, power triangle, improvement of power factor. (9 hours)

Three-phase AC Circuits: Generation of 3-phase balanced sinusoidal voltages, waveform of 3-phase voltages, phase sequence, star and delta connections, line voltage and phase voltage, line current and phase current, analysis of 3-phase circuit with star/delta connected balanced and unbalanced loads, Phasor diagram of voltages and currents, power measurement by two-wattmeter method with unbalanced and balanced loads. (6 hours)

Electrical Power System: Power system components, Overview of Electrical Machines. (2 hours)
Semiconductor Diode and its applications: I-V Characteristic, Static and dynamic Resistance, Half and Full Wave Rectifiers with and without filter, Zener regulator, 78XX regulator, Special purpose diodes. (9 hours)

BJT and its applications: I-V Characteristics, Cut-off, active and saturation mode of operation, CB, CC and CE configuration, Transistor Biasing: fixed and voltage divider bias. Transistor as an amplifier: RC coupled Amplifier, Transistor as a Switch: Relay Driver Circuit. (9 hours)

Principles of Electronic Communication: Fundamentals of Analog communication, Amplitude and Frequency modulation systems, Pulse modulation. Introduction to digital communication, Basic digital modulation schemes, Introduction to Mobile Communication and Communication networks. (6 hours)

TEXT / REFERENCES:

- Kothari D. P. & Nagarath I. J,, Basic Electrical Engineering, TMH 2013
- Nagasarkar T. K. & Sukhija M. S., Basic Electrical Engineering, OUP 2012
- Hughes E., Electrical and Electronic Technology (9e), Pearson Education, 2008
- Robert L. Boylestad, Louis Nashelsky, Electronic Devices & Circuit Theory, 11th Edition, PHI, 2012.
- Albert P Malvino, David J Bates – Electronic Principles,7th edition, TMH,2007.
- George Kennedy, Bernad Davis, Electronic Communication Systems, 5thedition,TMH, 2011
- Garcia and Widjaja, "Communication Networks", McGraw Hill, 2006
- Raj Pandya, "Mobile and Personal Communication Services And Systems", Wiley-IEEE Press, 2000.

LOGIC DESIGN

IEC 121 **3-1-0-4**

Number systems and Codes: Number systems - Binary, Octal & Hexadecimal systems, inter-conversions, addition and complement form subtraction.
Codes: BCD, EXCESS-3 codes, Gray codes, error detection and correction codes (Parity & Hamming code); BCD arithmetic. (6 hours)

Introduction to logic circuits: Digital logic gates, Universal gates, De Morgan's theorem, Boolean postulates and theorems, Simplification of Boolean expressions and Implementation of Boolean functions using logic gates.
Minimization methods: Simplification in SOP & POS forms, Karnaugh map (up to 5 variables), VEM, Quine McCluskey method. Implementation using basic gates.
(7 hours)

Combinational circuit design: Analysis and synthesis of Combinational circuits: Arithmetic circuits (Half adder, Full adder, half subtractor, Full subtractor, BCD adder, Adder/Subtractor using 2's complement), Code converters, Magnitude comparators, Multiplexers & De-multiplexers, Encoders & Decoders. (12 hours)

Digital system design using PLDs: Types of PLDs, Merits and demerits of PLDs, Implementation of Boolean Functions using PLD's (PAL, PLA & PROM). (4 hours)

Synchronous sequential circuit design: Comparison between combinational and sequential circuits, Latches, flip flops (SR, D, JK, and T flip-flops), Master-slave Flip-flops. Counters (ripple and synchronous), Ring & Johnson counters, Shift registers.
Design and analysis of synchronous sequential circuits: serial binary adder, sequence generators and sequence detector. (12 hours)

Introduction to HDL: HDL introduction, types, merits and demerits; Behavioral, Data flow and Structural modelling for combinational and sequential circuits using VHDL. (7 hours)

TEXT/ REFERENCES:

- William Fletcher, "An Engineering approach to digital design", PHI, 2009.
- Morris Mano, " Digital Design", Pearson
- Zve Kohavi, "Switching and finite automata theory", TMH, 2nd edition
- Stephen Brown, Zvonko Vranescic, "Fundamentals of digital logic with VHDL design", McGraw Hill, 3rd edition, 2009.
- J Bhaskar, "VHDL Primer", Prentice Hall, 3rd edition.
- C.H.Roth, "Fundamentals of Logic design", Cengage, 7th edition, 2013

III SEMESTER

IMA 231 – MATHEMATICS - III (Refer page no. **39**)

ANALOG ELECTRONIC CIRCUITS

IEC 231 **3–1-0–4**

Bipolar transistor: Structure of Bipolar Transistor, Operation of Bipolar Transistor in Active Mode: Collector Current, Base and Emitter Currents, Bipolar Transistor Models and Characteristics: Large-Signal Model, Small-Signal Model, Early Effect, operation of Bipolar Transistor in Saturation Mode (6 hours)

BJT Amplifiers: Input and Output Impedances, Biasing: DC and Small-Signal Analysis, Simple Biasing, Resistive Divider Biasing, Biasing with Emitter Degeneration, Self-Biased Stage, Amplifier Topologies: Common-Emitter, Common-Base, Emitter Follower.

(6 hours)

MOS Transistor: Structure and operation of MOSFET, I-V Characteristics, Channel-Length Modulation, Trans conductance, MOS Device Models: Large-Signal and Small-Signal Model, PMOS Transistor, Comparison of Bipolar and MOS.

(8 hours)

MOS Amplifier: Amplifier Topologies, Biasing, Realization of Current Sources, Common-Source Stage: CS Core, CS Stage with Current-Source Load, CS Stage with Diode Connected Load, CS Stage with Degeneration, CS Core with Biasing, Common-Gate Stage: CG Stage with Biasing, Source Follower: Source Follower Core, Source Follower with Biasing.

(8 hours)

Frequency Response: Fundamental Concepts: General Considerations, Relationship Between Transfer Function and Frequency Response, Miller's Theorem, General Frequency Response, High-Frequency Models of Transistors: High-Frequency Model of BJT and MOSFET, Transit Frequency, Frequency Response of CE / CS, CB / CG and Source / Emitter Followers.

(6 hours)

Feedback: Loop Gain, Properties of Negative Feedback: Gain Desensitization, Bandwidth Extension, Modification of I/O Impedances, Linearity Improvement, Types of Amplifiers: Simple Amplifier Models, Examples of Amplifier Types, Sense and Return Techniques, Polarity of Feedback, Feedback Topologies: Voltage-Voltage, Voltage-Current, Current-Voltage, Current-Current Feedback. (6 hours)

Oscillators: General Considerations, Heartley and Colpitts Oscillator, Phase Shift Oscillator, Ring Oscillator. (4 hours)

Power Amplifier: General Considerations, Different Classes of Power amplifiers, Class A amplifier, Class B amplifier and Class AB amplifer, Power efficiency of all Classes. (4 hours)

TEXT / REFERENCES:

- Behzad Razavi, "Fundamental of Microelectronics", Wiley, 2013.
- A. S. Sedra, K. C. Smith, "Microelectronic circuits", Oxford University Press, 2011.
- R. L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", 2009.
- J. Millman, C. C. Halkias, Chetan. D. Parekh, "Integrated Electronics", McGraw Hill. 2010.

ANATOMY AND PHYSIOLOGY

IBM 231 **4–0-0–4**

ANATOMY: Skeletal System:Types of bone, classification, Structure of bone, Blood supply, Cartilage: Type, Structure in brief, Joints:Classification, Structure of synovial joint, Major joints of the limbs and temporomandibular joint. Muscle tissue: Types, Structure of skeletal muscle, Types of muscles, Brain: Parts, Brain stem, Ventricles, CSE, Meninges, Cranial nerves (names and functions only). Spinal cord: Gross features and structures, Spinal nerve, Nerve endings and receptors, Autonomic nervous system. Sensory: Eye, Ear, Skin.Heart: Pericardium, Chambers, Blood supply Organs. Respiratory system: Parts, Trachea, Lungs.G I Tract: Parts, Stomach, Intestine, Liver, and Pancreas.Urinary system, Male and Female reproductive organs, and Endocrine glands. (25 hours)

PHYSIOLOGY: Introductory lecture pertaining basic functional concept of the human body as a whole and contribution of individual system for achieving the goal.Leverage system i.e. bone and muscle physiology in general.Nerve action potential and its ionic basis. Body temperature regulation
based on thermostats - principle and its operation in different environmental temperature and its abnormalities. Biophysical aspects of blood pressure (Bop) and its recording technique. Electrocardiograph and its gross normal features and alterations, Optics of the eye.Fundamental tonal analysis, determination of pitch, loudness and quality of sound. Sensorium - general role of receptor as transducers, generator potential. Motor control of skilled voluntary movements: Mechanism of abnormal oscillatory movements Electroencephalogram and electrocortcogram. (25 hours)

TEXT / REFERENCES:

- Charles E Tobin, Manual of Human Dissection, McGraw Hill, Edition 4, 1961.
- J Gibson, Modern Physiology and Anatomy of Nurses, Black Well, 1981.
- Best Charles Herbert, Taylor, Norman Burke, The living body.
- A J Vander, J H Sherman, D S Luciano, Human Physiology, McGraw Hill, Edition 8, 2000.
- Cyril A Keele, Eric Neil, Neil Norman Joels, Samson's Wright's Applied Physiology,Oxford University Press, 1993.

NETWORK ANALYSIS

IEE 231 **3– 1– 0 – 4**

Network Equations: Nodal and Loop analysis of networks for AC and DC excitation, Analysis of Coupled Circuits using loop analysis.

(4 hours)

Network Theorems: Superposition, Reciprocity, Thevenin's, Norton's and Maximum Power Transfer theorems. (7 hours)

Initial and Final conditions in networks: Behavior of circuit elements under switching condition and their representation. Evaluation of initial and final conditions in RL, RC and RLC circuits for DC and AC excitations. (8 hours)

First order and Second order differential equations: General and particular solutions of RL, RC and RLC circuits for DC and AC excitation. (8 hours)

Laplace transformation and its application: Solution of RL, RC, RLC networks using Laplace transformation method. (5 hours)

Linear wave shaping: Response of RC circuits to step, pulse, square wave and ramp input. (6 hours)

Network Functions for one port and two port network: Driving point functions, transfer functions. (3 hours)

Two port network: Open circuit impedance parameters, Short circuit admittance parameters, Transmission parameters, Hybrid parameters, Relationship between two port parameters, parallel connection of two port networks, Series connection of two port networks, Cascade connection of two port networks. (7 hours)

TEXT / REFERENCES:

- M. E. Van Valkenberg, "Network analysis", Prentice Hall of India, 2000.
- Franklin F. Kuo, "Network analysis and Synthesis", 2nd Edition, Wiley International.
- R C Dorf, J A Svoboda, "Introduction to Electric Circuits", Wiley, 6th edition
- Millman, H. Taub, "Pulse, digital and switching waveforms", 2nd Edition, McGraw Hill.

BIOSTATISTICS

IHS 231 **3 – 1 – 0 – 4**

Introduction: Types of research and role of statistics in research, data and learning, sources of data, methods of data collection, primary and secondary data, data summary, descriptive statistics and inferential statistics, types of data, and types of scales of measurement.

Probability distributions: Types of distributions, selection of confidence intervals, and choice of confidence intervals in biomedical research.

Sample Design: Meaning of sampling, advantages of sampling, sampling criterion, characteristics of good sample, unit of analysis, methods of sampling, and numerical example of sample size estimation in biomedical research.

Correlation & linear regression, multiple regression and applications in biomedical engineering.

Hypothesis Test: Role of hypothesis in biomedical research, criteria of hypothesis formulation, need for hypothesis, characteristics of hypothesis, types of hypothesis, decision rule in hypothesis testing, types of error in hypothesis testing, and numerical examples of hypothesis testing in biostatistics.

TEXT / REFERENCES:

- Sullivan, L. M. (2011). Essentials of biostatistics in public health. Jones & Bartlett Publishers.
- Campbell, M. J., Machin, D., & Walters, S. J. (2010). Medical statistics: a textbook for the health sciences. John Wiley & Sons.
- Motulsky, H. (2013). Intuitive biostatistics: a nonmathematical guide to statistical thinking. Oxford University Press, USA.
- Utts, J. M., & Heckard, R. F. (2011). Mind on statistics. Cengage Learning.
- Ropella, K. M. (2007). Introduction to statistics for biomedical engineers. Synthesis Lectures on Biomedical Engineering, 2(1), 1-94.

DIGITAL ELECTRONICS LABORATORY

IEC 232 **0–0-6–2**

Study of logic gates: Introduction to Logic gates.
Simplification of Boolean expressions and implementation using logic gates.
Universal logic.

Study of code converters: Odd/even Parity generator/checker, Binary to Gray code converter BCD to XS-3 code converter

Design and testing of Combinational circuits: Half & Full adder/subtractor, BCD adder, Binary parallel adder/subtractor.
Design and testing of Sequential Circuits: Latches, Flip-flops, Ripple counters, Synchronous Counters, Ring & Johnson Counters, Shift registers
Serial adder, Sequence generator and Sequence detector

HDL Programming for combinational and sequential circuits.

TEXT / REFERENCES:

- Morris M. Mano, Digital Design, Prentice-Hall, 2nd edition.
- William I. Fletcher, an Engineering Approach to Digital Design, Prentice Hall of India, 2009.
- Anand Kumar, Fundamentals of Digital Circuits, Prentice Hall of India 2nd edition, 2012.
- K. A. Krishnamurthy, Digital Lab Primer, Pearson Education.
- J Bhaskar, VHDL Primer, Prentice Hall, 3rd edition.

CIRCUIT SIMULATION LABORATORY

IEE 232 **0–0-3–1**

1. Circuit Simulation using MATLAB/ SIMULINK:
   MATLAB basics
   Steady-state analysis of circuits: Solution of algebraic equation.
   Transient analysis of circuits: Solution of system equations using ODE solvers.
   Introduction to SIMULINK.
   Introduction to GUIDE.

2. Circuit Simulation using PSPICE
   Introduction to PSPICE
   Steady state analysis of DC circuits, single & three-phase AC circuits, and coupled circuits.
   Transient analysis of DC & AC circuits.
   Frequency response of circuits
   Analysis of simple diode circuits.
   Analysis of BJT & FET circuits.

TEXT / REFERENCES:

- Rudra Pratap, Getting Started with MATLAB – A Quick Introduction for Scientists and Engineers, Oxford University Press, 2010.
- Shampine I.F, Solving ODEs with MATLAB, Cambridge University Press, 2003.
- www.mathworks.com
- Rashid M.H, Spice for Circuits and Electronics using PSPICE, PHI, 2004
- Conant Roger., Engineering Circuit Analysis with Pspice and Probe, MGH, 1993

IV SEMESTER

IHS 241 – ENGINEERING ECONOMICS & MANAGEMENT

(Refer page no. **45**)

IC SYSTEMS

IEC 241 **3- 0 -0 –3**

Differential amplifier: Analysis of emitter coupled differential amplifier, Characteristics of differential amplifier using small signal model, Determination of CMRR, Methods improving CMRR using constant current source. (4hours)

Operational amplifier: Block diagram of an operational amplifier, Ideal and practical characteristics of Operational amplifier, Inverting and non-inverting amplifiers, Offset voltages and currents, Balancing of operational amplifier, Measurement of input and output impedance, CMRR, Slew rate. (5 hours)

Linear applications of operational amplifier: Sign changer, scale changer, Phase shifter, summing amplifier, Integrator, Differentiator, V to I converters and I to V converters, Instrumentation amplifiers, Bridge amplifiers, Active filters, higher order LPF, HPF, BPF, BEF, All pass filter, Narrow Band pass filter. (10 hours)

Non-linear applications of Operational amplifier: Precision AC/DC converters, Peak detectors, Sample and hold circuit, Log and Antilog amplifiers, Analog multipliers and dividers. Comparators, Applications of comparators: Zero crossing detector, Schmitt trigger, Square wave and triangular wave generators, Pulse generators. (10hours)

Data Acquisition: Binary weighted register DAC, R-2R ladder network DAC, Flash type ADC, counter type ADC, Successive approximation ADC, and Dual slope integrating ADC. (5hours)

Timers: Basic Timer circuit, Timer IC 555 used as astable and mono-stable (negative edge triggered) multi-vibrator, Schmitt trigger. (5 hours)

Phase locked loops: Principle of operation of PLL, VCO IC 566 and PLL IC 565, and Applications of PLL as frequency multiplier. (5hours)

Voltage regulators: Study of series voltage regulator with pre regulator and short circuit protection circuits, Analysis and design of linear series voltage regulators using IC'S 78XX and 79XX series, LM317, LM337, 723 IC'S. (4hours)

TEXT / REFERENCES:

- Franco Sergio "Design with Op amps &Analog integrated electronics" McGraw Hill (2002)
- David L. Terrell, Butterworth-Heinemann(1996) "Op amp Design, Application, and Troubleshooting (1997)
- Ramakant A. Gayakwad, "Op.Amps and linear integrated circuit"s, PHI. (2000)
- Roy and Choudhary, (1991)"Linear Integrated circuits", Wiley Eastern (2003)
- R.L.Boylestead and L.Nashelsky, Electronic devices and circuit theory, PHI edition(2009)

SIGNALS AND SIGNAL PROCESSING

IEE 241 **3- 1 -0 –4**

Introduction to Signals and Systems: Definitions of signals and systems, classification of signals, basic operations on signals, elementary signals and functions, systems viewed as interconnections of operations, properties of systems. (8 hours)
Time domain representations for linear time-invariant (LTI) systems: Introduction, convolution: Impulse response representation for LTI systems, properties of the impulse response representation for LTI systems. Block diagram representations. (8 hours)
Fourier representations for signals: Introduction, Discrete-time periodic signals: The discrete-time Fourier series, continuous-time periodic signals: The Fourier series, Discrete-time non-periodic signals: The discrete-time Fourier transform, continuous-time non-periodic signals: The Fourier transform, properties of Fourier representations (Including Parseval's relations). (12 hours)

Applications of Fourier representations: Introduction, Frequency response of LTI systems, Fourier transform representations for periodic signals, Sampling Theorem, Reconstruction of continuous-time signals from samples. (4 hours)

Z-Transform: Introduction, the Z-transform, properties of the Region of convergence, Properties of the Z-Transform, Inversion of the Z-Transform (Using Partial fraction method), Transform analysis of LTI systems. (8 hours)

Frequency Response of Analog Filters:Frequency response of an LTI system, Butterworth filters, Chebyshev filters (Qualitative discussion). (2 hours)

Digital Filters: Relation between DTFT and Z-transform, Discrete Fourier Transform (DFT), N-point DFT computation. Introduction to digital filters: Finite impulse response (FIR) and infinite impulse response (IIR) filters, Ideal frequency responses of frequency selective filters. (6 hours)

TEXT / REFERENCES:

- Simon Haykin & Barry Van Veen, (2005), "Signals and Systems", John Wiley &Sons, New Delhi
- Proakis J.G and Manolakis D.G.Mimitris D. (2003) "Introduction to Digital Signal Processing" Prentice Hall, India.
- H.Hsu, R. Ranjan (2006) "Signals and Systems", Schaums's outline, Tata McGraw – Hill, New Delhi
- B.P.Lathi., (2005), "Linear systems and Signals", Oxford University Press.

LINEAR IC LABORATORY

IEC 242 **0- 0 -3 –1**

1. IC voltage regulators
2. Linear applications of op-amps
3. Nonlinear applications of op-amps
4. IC 555 Timer applications
5. PLL and its applications

TEXT / REFERENCES:

- Franco Sergio "Design with Op amps &Analog integrated electronics" McGraw Hill (2002)
- Ramakant A. Gayakwad, "Op.Amps and linear integrated circuit"s, PHI. (2000)
- Roy and Choudhary, (1991)"Linear Integrated circuits", Wiley Eastern (2003)

MICROCONTROLLERS

IBM 241 **3- 0 -3 –4**

Introduction: Microprocessors and microcontrollers: Microprocessor and Microcontroller structure, microprocessor Vs Microcontrollers, Microcontroller families. (2 hours)

The 8051 Architecture: 8051 Microcontroller Hardware, I/O pins, Ports, and Circuits, external memory, Counters and timers, serial data Input/ Output, Interrupts. (6 hours)

The 8051 programming: Addressing modes, Data move operations, Arithmetic operations, logical operations, Jump and Call Instructions, programming examples in assembly language and in "C". (10 hours)

Interfacing: External memory, Keyboard, Displays, Pulse measurement, D/A and A/D conversions, Multiple interrupts, Serial data communication, Stepper motor interfacing, Real time clock, and Microcontroller based systems. (12 hours)

PIC Microcontrollers: PIC18 Family overview, architectural features, Special features and Applications. (6 hours)

TEXT / REFERENCES:

- Kenneth J. Ayala, "8051 microcontroller and embedded systems using assembly and C" 3rd Edition, Cengage Learning, 2011.
- Muhammad Ali Mazidi, Janice Gillispie Mazidi, "The 8051 Microcontrollers and Embedded systems" Second Edition, Pearson Education, 2013.
- Myke Predko, "Programming and Customizing the 8051 Microcontroller" TATA McGraw Hill Edition, 2005.
- Muhammad Ali Mazidi, Rolind D. Mckinlay, Danny Causy, "PIC Microcontroller and Embedded Systems", 1st Edition, Pearson, 2011.
- Ramesh Gaonkar, Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family), First Edition, Penram, 2015.

BIOMEDICAL INSTRUMENTATION

IBM 242 **3- 1 -0 –4**

Biomedical transducers: Performance characteristics of the transducer, Types of transducers: Active & Passive, Pressure transducers: Resistive strain gauge, Differential capacitive & inductive transducer (LVDT), piezoelectric transducers, photoelectric Transducers: Photoemmisive, photoconductive and photovoltaic type, Photomultiplier tube, Temperature transducers: Resistive thermometers, Thermistors & Thermocouple. (10 hours)

Electrodes & Amplifiers: Half-cell potential and factors affecting the electrode potential, Ag/ AgCl electrode: methods to manufacture the electrode: Electrolytic method and sintering process, Electrode-Electrolyte model, Instrumentation amplifier, Bio potential electrode classification, Surface electrode, needle electrode & Microelectrodes and the equivalent circuit model of a microelectrode. (10 hours)

Physiological Signals & Measurements: Basics of ECG, EMG, EEG, PCG and Instrumentation for measuring these signals, Measurement of blood pressure: Indirect and Direct methods, Measurement of blood flow by Electromagnetic & Doppler method, Plethysmographic method for blood volume measurement. (8 hours)

Cardiac Pacemakers: Types: Asynchronous (fixed rate) and Synchronous pacemaker (demand type and atrial synchronous pacemaker), External and Implantable pacemakers. Modes of triggering of the pacemaker, Pacemaker power supplies & pacemaker electrodes, coding of the pacemakers. (6 hours)
Defibrillators: AC and DC defibrillators, Types of electrodes and their features, cardioverter. (3 hours)

Lasers: Principle of laser operation, different types of lasers and their medical applications, laser safety. (4 hours)

Recorders: Basic recording system, Types of recorders & their principle of working and applications. (3 hours)

Electrical Hazards & Safety: Electrical hazards during bioelectric monitoring, General concepts of electric shock: Micro and macro shock, physiological effects of electric current, Precautions to minimize electric shock hazard, Methods of accident prevention: Grounding, double insulation, protection by low voltage, ground fault circuit interrupter & isolation of patient connected parts. (4 hours)

TEXT / REFERENCES:

- John G Webster, "Medical Instrumentation Applications and Design", John Wiley and Sons, Edition 3, 2008.
- Leslie Cromwell, "Biomedical Instrumentation and Measurements", PHI Learning, Edition 2, 2010.
- R S Khandpur, "Handbook of Biomedical Instrumentation", TMH, Edition 2, 2007.
- L A Geddes, L E Baker, "Principles of Applied Medical Instrumentation", Wiley India, Edition 3, 2008.
- Joseph J Carr, John M Brown, "Introduction to Biomedical Equipment technology", Pearson Education, Edition 4, 2003.

BIOMATERIALS

IBM 243 **3- 0 -0 –3**

Introduction to Bio-materials: definition of biomaterials, requirements and its uses, classification of biomaterials, performance of biomaterials. (2 hours)

Types of biomaterials: Metallic Biomaterials- introduction, types - Stainless steel, Co-Cr alloys, Ti alloys, dental metals and other metals, corrosion behavior. Ceramic Biomaterials: introduction, Classification - Non-absorbable or relatively bioinert bioceramics. Biodegradableor Resorbable ceramics. Bioactive or surface reactive ceramics. Polymeric Biomaterials: introduction, polymerization and its types, basic structure, classification solid state properties, discussion on different class of synthetic non-degradable polymers Biodegradable Polymeric Biomaterials, Biologic Biomaterials: Tissue Derived Biomaterials; Composite Biomaterials: introduction, structure, types, properties and applications. (18 hours)

Implantable Medical devices : (a) Orthopaedics-joint replacement, bone defects, bone fracture, cartilage defects, (b) Cardiovascular system- arteries and veins, Heart valve prostheses-introduction, causes, mechanical and bioprosthetic heart valves. (c) eyes and ears-contact lenses, IOL, cochlear implant, (d) dentistry, maxillofacial and craniofacial – dental implants, craniofacial reconstruction , (e) general soft tissue repair. (12 hours)
Biomaterials for regenerative medicine-background, tissue engineering templates, types of template materials, fabrication route (4 hours)

TEXT / REFERENCES:

- Joseph D Bronzino, "The Biomedical Engineering Handbook", Third Edition, 2006, CRC press, USA.
- Park Joon Bu, "Biomaterials Science and Engineering", First Edition, 1984, Plenum Press, University of Michigan.
- Buddy D Ratner & Allen S Hoffman, "Biomaterials Science and Introduction to Materials in Medicine", Third Edition, 2012, Academic Press, Canada.
- L.L.Hench & E.C.Ethridge, "Biomaterials, an Interfacial Approach", First Edition, 1982, Academic Press, New York.
- David Williams, Essentials Biomaterials Science, 2014, Cambridge university press.ISBN:978052189908-6

V SEMESTER

PROJECT WORK

IBM 351 **0-0-36-12**

Students need to form batches with maximum four in numbers and required to identify the problem in their area of interest within their discipline of study under the supervision of a faculty (Guide) for 12 to 14 weeks. At the end, the findings need to be presented in the form of a project report for final evaluation.

VI SEMESTER

BIOMEDICAL DIGITAL SIGNAL PROCESSING

IBM 361 **4-0-3-5**

Review of Signals & Systems: Introduction, Sampling and Digitization, Discrete-time signals and systems, LSI Systems, Properties; Stability & Causality, Frequency-response. The Z-transform, ROC, Properties, transform analysis of LSI systems. (10 hours)

The Discrete Fourier Transform (DFT): the discrete time Fourier series (DTFS), properties; The DFT and its properties, linear convolution using the DFT; The fast Fourier transform (FFT): radix 2 DITFFT & DIFFFT, In-place computation, bit-reversed sorting. (16 hours)

Digital filters: Introduction, FIR and IIR Filters; FIR Filters: properties, examples; Design of general FIR filters: window-method. IIR Filters: Design of IIR filters from analog filters: Motivation; Butterworth and Chebyshev filters; digital filter design techniques: impulse-invariance-method and bilinear transformation; Comparison of FIR and IIR Filters. Basic network structures for IIR and FIR systems - Direct, parallel, and cascade forms.
(14 hours)

Biomedical Engineering Applications: Autocorrelation, cross-correlation, power spectrum density (PSD) and their applications. The ECG waveform and its utility in medical diagnosis. The R-R interval series and its significance; detection of the QRS complex and estimation of the

RR interval series through digital filtering techniques. The periodogram and Welch's method of estimating the PSD; PSD of the RR interval series and heart-rate variability. Data compression techniques: AZTEC and CORTES algorithms, fan algorithm and Huffmann coding. (8 hours)

TEXT / REFERENCES:

- Oppenheim A.V. and R.W. Schafer, Digital Signal Processing, Prentice Hall of India, 2002.
- Simon Haykin and Van Veen, Signals and Systems, John Wiley, Edition 2, 2002.
- Munson Hayes, Digital Signal Processing (Schaum's outline on), Second Edition, McGraw Hill 2011.
- W J Tompkins, Biomedical Digital Signal Processing, Prentice Hall, 2002.
- R.M. Rangayyan, Biomedical Signal Analysis: A Case Study Approach, IEEE Press Series in Biomedical Engineering, John Wiley & Sons, 2002

BIOMECHANICS

IBM 362 **4-0-0-4**

Basic terminology, Anatomical movement descriptors, Reference systems. Biomechanical principles of human movement. Qualitative analysis of human movement. (4 hours)

Skeletal considerations for movement: composition & structure of bone, bone types & biomechanics, fracture & failure mechanics, design requirement of bone. Mechanical loads on bone. (3 hours)

Muscular considerations for movement: Muscle tissue properties, Functions of a muscle, Skeletal muscle structure (physical organization of muscle), Force generation in the muscle, Role of muscle, Force-velocity relationships in skeletal muscle, Joint flexibility. (11 hours)

Fundamental concepts of gait: Gait, Gait cycle, Phases and Sub-phases of Gait cycle, Temporal variables and Distance variables, fundamental concepts, Measurement approaches and systems. (3 hours)

Linear Kinematics: Definitions, Collection of kinematic data, Position and Displacement, Velocity and Speed, Acceleration, Differentiation and Integration, Projectile Motion, Equations of constant acceleration. Linear Kinematics of walking & running. (3 hours)

Angular Kinematics: Angular Motion, Measurement of Angles, Types of Angles, Lower extremity joint angles, Angular Motion Relationships, Relationship between Linear and Angular Motion, Angle-Angle Diagrams. (2 hours)

Linear Kinetics: Force, Laws of Motion, Types of Forces, Representation of forces acting on a system – analysis using Newton's law of motion (effects of a force at an instant in time, effects of force applied over a period of time, effect of a force applied over a distance), Special Force Applications. (6 hours)

Angular Kinetics: Torque or Moment of Force, Newton's laws of Motion (Angular Analogs), Center of Mass, Rotation and Leverage, Types of Torque, Analysis using Newton's laws of motion (effects of torque at an instant in time, effects of a torque applied over a period of time and effects of torque applied over a distance), Special Torque Applications. (9 hours)

Application of Aerodynamics in Sports: Aerodynamic drag force, Effects of drag on the body and objects in sport- activities, Aerodynamic lift force- Lift force acting on shapes and surfaces, Effects of lift on projected objects, Lift force produced by spin - The Magnus effect. (4 hours)

Application of Hydrodynamics in Swimming: Buoyancy and Floatation, floating ability of the human body, Types of floaters, Different floating positions of the human body, Resistive forces in swimming skills, Propulsive forces in swimming skills, Swimming efficiency and speed. (3 hours)

TEXT / REFERENCES:

- Joseph Hamill and Kathleen M. Knutzen, *Biomechanical Basis of Human Movement*, Lippincott Williams & Wilkins, Fourth Edition, 2014, Philadelphia.
- Ellen Kreighbaum, Katharine M Barthels, *Biomechanics-A Qualitative Approach for studying Human Movement,* Allyn and Bacon Publishers, Fourth Edition, 1995, USA.
- Susan J. Hall, *Basic Biomechanics*, McGraw-Hill International Editions, Fifth Edition, 2006, Singapore.
- Duane Knudson, *Fundamental of Biomechanics*, Kluwer Academic/Plenum publishers, Second Edition, 2007, Chico, California.

ELECTIVE - I

IBM 363 **3-0-0-3**

ARTIFICIAL NEURAL NETWORKS:

Artificial Neural Networks: Introduction, Machine learning, Pattern and data, Methods for pattern recognition tasks, Basic Models of neural networks, Terminologies. Training and testing, Learning methods. (8 hours)

Functional units of ANN for pattern recognition tasks: Pattern recognition problems, Basic functional units, Feed forward neural networks: Analysis of pattern association networks, Analysis of pattern classification networks, Examples (McCulloch-Pitts Neuron, Hebb net, perceptron). (10 hours)

Multilayered network (Back propagation network), Feedback neural networks, Associative memory networks Competitive learning neural networks. (10 hours)

Design cycle, Biomedical applications of ANN: Diagnosis of cardiovascular system, Analysis of pathology images and magnetic resonance medical images. (8 hours)

TEXT / REFERENCES:

- S. N. Sivanandam, and S. N. Deepa, "Principles of Soft Computing", Wiley India Edition, New Delhi, 2010.
- S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Neural Networks using MATLAB 6.0", TATA McGRAW HILL, New Delhi, 2006.
- B Yegnanarayana, Artificial Neural Networks, Prentice Hall, 2001.
- D L Hudson and M E Cohen, Neural Networks and Artificial Intelligence for Biomedical Engineering, Prentice Hall, 2001.

- Earl Gose, Richard, Johnson Baugh and Steve Jost, "Pattern recognition and Image analysis", Prentice Hall, New Delhi, 2002.

TELEMEDICINE:

History of Telemedicine, Block diagram of telemedicine system, Definition of telemedicine, Tele health, Tele care, origins and Development of Telemedicine, Scope, Benefits and limitations of Telemedicine; Components of a data communication system, Types of data, Spectrum and bandwidth, analog and digital communication, transmission impairments & channel capacity, Guided & Unguided transmission media. (10 hours)

Transmission of analog signal: Need for modulation, Frequency translation, Types of Amplitude Modulation (AM) techniques: Double Side Band (DSB) modulation, Single Side Band modulation, Vestigial Side Band (VSB) modulation; Frequency Modulation (FM) System: Phase and Frequency modulation, FM spectral analysis & FM bandwidths; Analog to digital conversions: Pulse amplitude, pulse width and pulse position and pulse code modulation; Digital modulation techniques. (15 hours)

Multiplexing Techniques: TDM, FDM; TDMA, FDMA & CDMA; Types of Network: BAN, LAN, MAN & WAN; Types of wireless network; Switching Techniques: Circuit switching & packet switching techniques; Reference models: ISO-OSI (Open Systems Interconnection) architecture. (5 hours)

Data Security and Standards: Encryption, Cryptography: Symmetrical & Asymmetrical Cryptography, Mechanisms of encryption, Biometric security & identification; Ethical and legal aspects of Telemedicine. (3 hours)

Applications of Telemedicine: Tele radiology, Tele Pathology, Tele cardiology, Teleoncology; Videoconferencing. (3 hours)

TEXT / REFERENCES:

- Behrouz A Forouzan, "Data Communication and Networking", McGraw Hill Education (India) Pvt. Ltd., 5th Edition, 2013.
- Bernard Fong, A.C.M. Fong, C.K. Li, "Telemedicine technologies: Information technologies in Medicine and telehealth", John Wiley & Sons, UK, 2011.
- Andrew S Tanenbaum, Computer Networks, Pearson Education, Inc., 2010.
- Olga Ferrer-Roca, M.Sosa Ludicissa, Handbook of Telemedicine,IOS press 2002.
- A.C.Norris, Essentials of Telemedicine and Telecare, John Wiley & Sons, 2002.
- Richard Wootton, John Criag and Victor Patterson, Introduction to Telemedicine, CRC Press, 2006.

ELECTIVE - II

IBM 364 **3-0-0-3**

PATTERN RECOGNITION:

Introduction to Pattern Recognition, Definitions: pattern, feature, feature vector, feature space, training samples, cost, decision theory, decision boundary, Pattern recognition system, design cycle, Learning and adaptation. (6 hours)

Introduction to Statistical Pattern Recognition, Basics of Probability theory, Bayes Rule, Maximum Likelihood Classification and Special Cases, Maximum Likelihood Parameter Estimation. (8 hours)

Non-parametric techniques: Introduction, Density estimation, Parzen window, k-Nearest Neighbor estimation, The Nearest Neighbor rule, Curse of dimensionality: Component analysis and Discriminants. (8 hours)

Linear Discriminant Functions: Introduction, LDFs and Decision Surfaces, Generalized LDFs, Linearly separable case, Non separable behavior, Fisher Linear Discriminant Analysis, Multiple Discriminant Analysis, Support Vector Machine, Multilayer Neural Networks for pattern recognition. (8 hours)

Unsupervised Learning: Parametric and non-parametric approaches, Nonparametric unsupervised learning: Clustering - Flat Clustering, Decision Trees and Hierarchical Classification; Ensemble Classifiers: Bagging, Boosting, Component Classifiers; Clustering Algorithms; Performance Analysis; Applications. (6 hours)

TEXT / REFERENCES:

- R.O. Duda, P.E. Hart, and D.G. Stork, 'Pattern Classification', New York: John Wiley,2001
- Earl Gose, Richard Johnsonbaugh, Steve Jost, 'Pattern Recognition and Image Provessing', PHI, 2009.
- R. Schalkoff 'Pattern Recognition: Statistical, Structural and Neural Approaches', Wiley,1992.

PHYSIOLOGICAL CONTROL SYSTEMS:

Introduction to Control systems, Open loop and closed loop feedback control systems and examples, effects of feedback on overall gain, stability, sensitivity and external noise. (2 hours)

Modeling of physical systems, mechanical systems, mechanical translational and rotational systems. (3 hours)

Transfer functions, Block diagram algebra, block diagram reduction technique and simplification. Signal flow graphs, Mason's rule, features of signal flow graphs, construction of signal flow graphs using Mason's Formula. (4 hours)

Time response analysis, test signals, first order systems, second order systems, evaluation for the time domain specifications, transient response, Steady state errors and error constants, type of system, steady state error for non- unity feed-back system (4 hours)

Concept of stability, Routh-Hurwitz criteria and applications. (2 hours)

Root Locus Techniques, rules for constructing a root locus. Construction of root locus to find the stability of the system. (4 hours)

Bode plots, Log magnitude plots and phase plots, Gain margin, Phase margin and stability of the system. (3 hours)

Introduction to physiological control system, Differences between technological and physiological control system, Regulation of Electrolytic concentration, Extracellular fluid osmolarity, Acid base balance, Red blood cell production, Arterial pressure, Blood volume.

(3 hours)

Physiological system differential equations, modeling the body as compartments, and Behavior in simple compartmental system. (3 hours)

The Human Thermal Systems, Heat production, Loss of heat to the environment, Heat transfer within the body. (4 hours)

Human eye tracking of a periodic function, Pupil control system. Respiratory system, and Cardio-vascular system. (4 hours)

TEXT / REFERENCES:

- Howard T Milhorn, "*The applications of control theory the physiological systems*", W B Saunders, 1966.
- David O Cooney, "*Biomedical Engg. Principles*", Marcel Dekker, 1976.
- Benjamin C Kuo, "*Automatic Control Systems*", Prentice Hall, Edition 7, 1997.
- Joseph, Alan, Ivan J, "*Feedback and Control Systems*", McGraw Hill.

ELECTIVE - III

IBM 365 3-0-0-3

DRUG DELIVERY:

Drug delivery system: overview, dosage form-tablet, capsule, parenteral etc. classification of drug delivery system, chemically controlled system, diffusion controlled system, controlled release mechanism- Membrane reservoir system, Matrix system, swelling controlled release system, biodegradable controlled release system. (6 hours)

Fundamental aspects of drug delivery: introduction of pharmacokinetics and pharmacodynamics, diffusive transport, diffusion in heterogeneous system, passage of drug through membrane drug release kinetics from different biopolymer matrices.
(8 hours)

Pharmacokinetics: common routes of systemic drug administration, drug absorption, bioavailability, determinants of bioavailability- disintegration, dissolution, drug distribution, drug elimination. (10 hours)

Matrix based drug delivery system: Polymer based matrices; hydrogels- drug carriers, transdermal and trans mucosal drug delivery system, measuring in vitro diffusions, measuring controlled release kinetics, drug targeting approaches, biocompatibility aspects of matrices.
(6 hours)

Immunity and immunological preparations: immunity, types, immunological preparations; bacterial vaccines, vaccines containing living viruses, vaccines containing toxoids.
(6 hours)

TEXT / REFERENCES:

- Maria A. Popescu, Drug Delivery, Nova Publishers USA, ISBN: 978-1-61324-538-5.
- B. Wang, T. J. Sahaan, R. A. Soltero, Drug Delivery: Principles and applications, John Wiley & Sons Inc, ISBN: 978-0-471-47489-0
- L Shargel, S Wu-Pong, A Yu, Applied Biopharmaceutics& Pharmacokinetics, Sixth Edition, 2005, The McGrow Hill, ISBN-13: 978-007-160393-5

- S. Rosenbaum, Basic Pharmacokinetics and Pharmacokinetics, Wiley, 2011, ISBN 978-0-470-56906-1

IMAGE PROCESSING:

Review of signals, systems & transforms; 2D signals & systems, 2D DFT and its computation. (6 hours)

Image perception – the human vision system, psycho-visual experiments, monochrome vision model, temporal properties. (3 hours)

Image Enhancement: Point operations, Spatial filtering: linear filters & the median filter. (8 hours)

Image compression – the discrete cosine transform (DCT), properties, computation, practical compression algorithm, Compression standards. (4 hours)

Medical Imaging: Imaging modalities; Computed tomography (CT): mathematical basis, the Radon transform & the central slice theorem; Image reconstruction from projections: the Direct Fourier Method, convolution backprojection algorithm, reconstruction from fan-beam projections; X-rays: utility, generation and detection; X-ray CT systems. Emission CT: principles, Positron emission tomography; Magnetic resonance imaging: Principles of data-generation, resolving the tissues, resolving the spatial locations. (15 hours)

TEXT / REFERENCES:

- R.C Gonzalez and R.E. Woods, Digital Image Processing, 2nd Ed., Pearson Education Inc., Eighth Indian Reprint, 2002.
- Jae S. Lim, Two-dimensional Signal and Image Processing, Prentice-Hall, Englewood Cliffs, New Jersey, 1990.
- A.K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall, 1989, Fourth Indian Reprint.
- A.C. Kak and M. Slaney, Principles of Computerized Tomographic Imaging, SIAM's Classics in Applied Mathematics, Philadelphia, SIAM, 2001.
- Kline Jacob, Handbook of Biomedical Engineering, Academic Press, 1988.

ELECTIVE - IV

IBM 366 3-0-0-3

EMBEDDED SYSTEMS:

Introduction to Embedded Systems: An embedded system, processor in the system, hardware nits, and software embedded into a system, example of an embedded system. (2 hours)

Architecture of Embedded Systems: Hardware architecture, software architecture. Hardware platforms. Programmable System on Chips (PSOCs), Building blocks of PSOC. Memory devices. (4 hours)

Programming concepts: Embedded programming in C: Embedded C program elements, keywords and identifiers, data types and storage class. Embedded C arithmetic, logical and relational operations, Structure in embedded C programming, structure padding, structure and bit fields. (6 hours)

Interfacing: Serial Peripheral interface (SPI), Inter-Integrated Circuit (I^2C), RS-232, Universal Serial Bus (USB), Infrared Communication (IrDA), Controller Area Network (CAN), and the Bluetooth. (8 hours)

Real-Time Operating systems: Basic Features of an Operating System, Kernel Features, Processes and Threads, Context Switching, Scheduling, Inter-process Communication, Real-time Memory Management, I/O, Example Real-time OS, Evaluating and Optimizing Operating System Performance. (10 hours)

Hardware Software Co-simulation: Co-simulation approaches, typical co-simulation environment, Embedded System Development Life Cycle (EDLC). (6 hours)

TEXT / REFERENCES:

- Shibu K V, "Introduction to Embedded Systems", TMH, First Edition, 2012.
- Dr. K.V. K. K. Prasad, "Embedded/Real-Time Systems: Concepts, Design and programming", Dreamtech Press, 2011.
- Peckol James K, "Embedded systems", John Wiley and Sons, New Delhi, 2013.
- Frank Vahid and Tony Givargis, "Embedded system Design – a Unified Hardware/Software Introduction" Wiley India Pvt. Ltd, New Delhi, 2013.

TISSUE ENGINEERING:

Introduction: Basic definition, Structural and organization of tissues: epithelial, connective tissues; Sterilization process: Introduction, different sterilization methods: physical, chemicals; applications in terms of tissue engineering. (6 hours)

Morphogenesis, generation of tissue in the embryo: introduction, cardiac cell development, blood vessels development, skin tissue development; future development;
Tissue homeostasis: introduction, mechanism; tissue with no potential of regeneration, high potential of generation; consequence of regeneration in tissue engineering perspective. (6 hours)
Cellular signaling: introduction, cellular signaling in skin, bone cartilage biology; understanding and implementing principles of cell signaling in tissue engineering ; Stem cell: introduction, types, embryonic and adult stem cells, future perspective. (12 hours)

Cell culture, cell source, cell types, various aspects; cell-cell interaction, Molecular biology aspect. (4 hours)
Scaffold: polymer, natural polymer for tissue engineering, degradable materials, various type of scaffold, cell –matrix interaction, ECM. (4 hours)

Engineering tissues for replacing bone, cartilage. (4 hours)

TEXT / REFERENCES:

- Satya Prakash, D.S. Tim, Stem cell bioengineering and tissue engineering microenvironment, World Scientific, 2012 ISBN: 139782837882
- Endarle, Blanchard & Bronzino, Introduction to Biomedical Engineering, Academic press, 1998
- Frontiers in tissue engineering C.W. Patrick Jr., A. G. Mikos, L.V. Mcintire, Pergamon, Elsevier, 1998 ISBN: 008042689 1

- B. O Palsson, Sangeeta N. Bhatia , Tissue Engineering, Edition 1, 2004 Pearson , New Jersey, USA, ISBN 0-13-041696-7

SEMINAR

IBM 367 **0-0-3-1**

Students need to present a seminar on a topic of recent developments in their subject filed.

B.Sc. (CHEMICAL)

II SEMESTER

IMA 121 – MATHEMATICS - II (Refer page no.**33**)
IPH 121 – PHYSICS - II (Refer page no.**33**)
ICH 121 - CHEMISTRY (Refer page no.**35**)
IME 121 – ENGINEERING GRAPHICS - II (Refer page no.**36**)

CHEMICAL PROCESS CALCULATIONS

ICHM 121 **3-1-0-4**

Introduction to chemical engineering, unit operations, unit processes, importance of chemical engineering. Chemical engineering as profession.

Review of units and dimensions, conversion of units, physical and chemical properties of compound and mixtures; Techniques of problem solving, choosing basis, chemical equation and stoichiometry; single phase systems; ideal and real gases; degrees of freedom.

Phase equilibrium, vapour pressure, Gibbs phase rule; gas liquid system, Raoult's and Henry's law; Bubble and dew point calculations; Humidity charts and their uses.

Steady state material balances: Program of analysis of material balance problems; material balance for various unit operations; material balance involving multiple sub-system; material balance with chemical reactions. Material balance involving recycle, bypass and purge calculations.

Energy and energy balances: Balances on non-reactive process; Heat of mixing and solution; balance on reactive processes; calculations of heats of reaction; formation and combustion, adiabatic temperature.

TEXT/ REFERENCES:

- A. Hougen, K.M. Watson and R. A. Ragatz, Chemical Process Principles, Part – I, CBS publishers and distributors, 2nd edition, 2004.
- David M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, Eastern Economy ed., Prentice Hall of India (P) Ltd , 7th edition, 2009
- Richard Felder and Ronald W. Rausseau, Elementary principles of Chemical Processis, 3rd edition, John Wiley and Sons, 2008.

CHEMICAL ENGINEERING THERMODYNAMICS – I

ICHM 122 **3-1-0-4**

Basic concepts and definition: Classical and Statistical thermodynamics, system, boundary, surroundings, internal energy, work, heat, equilibrium, reversible process, intensive and extensive function, ideal gas temperature scale.

First law of thermodynamics for non-flow process, flow process, State and path function, Enthalpy, Heat capacity

PVT behavior of gases: Ideal gas, definition, ideal gas law, equation of state for real gases, graphical representation of P-V-T behavior, V-T diagram, P-V diagram and P-T diagram, Thermodynamic analysis of processes. Generalized correlations for thermodynamic property of gases, reduced equation of state, two parameter and three parameter correlations

Second law of thermodynamics: Spontaneous process, qualitative difference between heat and work, heat reservoir, heat pump, heat engine, Kelvin Plank statement, Clausius statement, irreversibility, entropy, Carnot principle, postulates, thermodynamic temperature scale, third law of thermodynamics.

Thermodynamic relations: Classification of thermodynamic processes, Helmholtz and Gibbs free energy, fundamental property relations, Maxwell's relations and their applications, Clausius-clapeyron equation, modified equations for U, H and S, relationship between Cp and Cv, ratio of heat capacity, effect of pressure and volume on Cp and Cv, Gibbs Helmholtz equations.
Applications of laws of thermodynamics:
Refrigeration, choice of refrigerant, Carnot cycle, vapour compression cycle, air refrigeration, Heat pumps, Liquefaction processes, free expansion, isotropic expansion, Steam power plant, Rankine cycle, Reheat and regenerative cycles. Internal combustion engines.

TEXT/ REFERENCES:

- K.V. Narayanan, A Text Book of Chemical Engineering Thermodynamics, Prentice Hall of India, 2006
- J.M Smith, H. C. VanNess and M.M.Abbot, Introduction to Chemical Engineering Thermodynamics, (7e), McGraw Hill, 2004
- T.E. Daubert, Chemical Engineering Thermodynamics, McGraw –Hill , 1985
- Y.V.C.Rao, Chemical Engineering Thermodynamics, Universities Press, 2004

III SEMESTER

IMA 231 – MATHEMATICS - III (Refer page no.**39**)

FLUID FLOW OPERATIONS

ICHM 231 **3–0-6–5**

Introduction to fluid flow: Different types of fluids and flow. Properties of fluids, Rheological classification, Different non- Newtonian fluids and their constitutive equations. Fluid statics – static pressure, variation of pressure with elevation, pressure measurement, Manometers.

Basic equations of fluid flow: Principle of continuity, one – dimensional Euler's equation and Bernoulli's equation and their applications, Impulse momentum equation.

Laminar flow: steady incompressible viscous flow through round pipes, Hagen – Poiseuilli's theory, Flow between parallel plates, Flow through concentric circular annulus, coutte flow.

Turbulence:Semi empirical theories of turbulence, Turbulent flow in smooth pipes, Power law, universal velocity distribution laws, Darcy's equation, losses in pipe flow, pipe flow problems.

Fluid flow around immersed bodies : Boundary layer and friction drag, Drag coefficient, Laminar and turbulent boundary layers on a flat plate, separation of boundary layer, surface, form, profile drag in flat plates, boundary layer control.

Motion of particles through fluids, Stoke's equation, Flow of fluids through beds of solids, Fluidization principles.

Compressible flow: Thermodynamic considerations, sonic velocity, Mach number, Basic equations of one dimensional compressible flow, Reversible adiabatic flow, Effect of area variation in compressible flow, Flow in convergent divergent passages, Flow in constant area pipes with friction.

Flow measurement : pilot tube, venture and Orifice meters, flow nozzle, variable area meters, compressors and pumps

TEXT / REFERENCES:

- McCabe and Smith, Unit operations in Chemical Engineering, McGraw – Hill 7th Edition. 2005
- Coulson and Richardson, Chemical Engineering Volume I, Elsevier India private limited, 5th Edition. 2006
- Frank M. White, Fluid Mechanics, McGraw – Hill, 6th edition, 2009
- Pai, Fluid Mechanics John Wiley, 1961

FLUID FLOW OPERATIONS LAB:

The experiments are conducted and mini project can be given based on the following topics:
Type of flow determination by Reynolds experiment – Flow through Venturi meter, orifice meter, circular pipe, annulus, v-notch, packed bed and fluidized bed to determine the characteristics of flow, pressure drop in fluid, discharge coefficients. Experiment on centrifugal pump to establish its characteristics.

CHEMICAL ENGINEERING THERMODYNAMICS – II

ICHM 232 3–1-0–4

Thermodynamic properties of pure substances: fugacity, fugacity coefficient, compressibility factor, activity.
Solution thermodynamics: Ideal and non-ideal gas mixtures and liquid solutions, partial molar properties, physical significance and determination methods, chemical potential.
Gibbs-Duhem equation: general form, various forms of Gibbs-Duhem equation, applications, limitations; Property changes of mixing, excess properties. Criteria of phase equilibrium, Duhemtheorem.Vapour liquid equilibrium, VLE equation, low pressure VLE, Phase diagrams for binary solution, T-x-y and P-x-y diagrams. Effect of pressure on VLE.Azeotropes and its types.
Activity coefficient; equations used for the determination, Margules, van Laar, Wilson equations, VLE at high pressures, bubble point, dew point calculations, Thermodynamic consistency tests for VLE data.
Chemical reaction equilibrium; criteria of equilibrium, Reaction stoichiometry, equilibrium constant, Gibbs free energy change, choice of standard state, feasibility of chemical reactions,

effect of temperature on equilibrium constant, evaluation of van't Hoff constant, Effect of parameters like temperature, pressure, composition on the equilibrium conversion.

TEXT / REFERENCES:

- K.V. Narayanan, A Text Book of Chemical Engineering Thermodynamics, Prentice Hall ofIndia, 2006
- J.M Smith, H.C.VanNess and M.M.Abbot,Introduction to Chemical Engineering Thermodynamics, (7e), McGraw Hill, 2004
- T.E. Daubert, Chemical Engineering Thermodynamics, McGraw –Hill , 1985
- Y.V.C.Rao, Chemical Engineering Thermodynamics, Universities Press, 1997

PROCESS PLANT MATERIALS

ICHM 233 3–0-0–3

Structure of solids, Iron Carbon diagram
Introduction of nanomaterials and their application in Chemical Engg.
Selection of process materials: Chemical and physical factors, economic considerations – fabrication, mechanical properties and strength of materials, effect of temperature on mechanical properties, testing and inspection of materials.
Properties and uses of ferrous metals: Cast iron, plain carbon steels, classification of steel, alloy steels, thermal and electrical insulating materials.
Non-ferrous metals and alloys, generalized properties and field of application of non-metals ,wood, stoneware, glass and fused silica- carbon- natural and synthetic rubber.
Plastics as material of construction for chemical plant; PVC, PTFE, glass fiber reinforced plastics – glass, rubber and metal lining of process vessels.
Corrosion resistance: Uniform, galvanic, pitting, crevice, intergranular, erosion, selective leaching and stress corrosion, high temperature oxidation, hydrogen embrittlement, selection of corrosion resistance. Methods of Corrosion measurement.

TEXT / REFERENCES:

- Fontana M.G. – Corrosion Engineering,3rd edition, McGraw Hill, 2009
- Vanvlack – Elements of Material Science, Pearson Education limited, 6th Ed. 2009
- T.Pradeep – Nano: The essentials, McGraw Hill, 2011.
- S.K. Hajra Choudhury – Materials science and processes, Indian Book Distributing Co., 2nd edition, 2008.

ORGANIC CHEMISTRY- I

ICH 231 4 - 0 - 0- 4

Preparation, Physical, Chemical properties and Industrial uses of aliphatic hydrocarbons (alkanes, alkenes, and alkynes), allyl halides, alcohols, acids, amines, aldehyde and ketones.

(18 hours)

Carbohydrates: Nomenclature, Classification, Mono-saccharides and their general reactions, Ring Structure of glucose & fructose, Optical activity, Determination of specific rotation using polarimeter, Descending-Ascending of sugars, Interconversion of aldose and ketose,

Disaccharides, Sucrose Manufacture from sugar cane, Properties and structure of sucrose, maltose & lactose, Polysaccharide, Starch, Cellulose. (8 hours)

Amino acids: Classification, Natural amino acids, Zwitter-ion, Isoelectric point, General methods of preparation and properties, Peptides, Poly peptides, Methods of preparation, Terminal residue analysis, Proteins, Classification and general properties, Color tests, Enzymes, Co-enzymes, Specificity of enzymatic actions, Enzymatic reactions, Applications of enzymes. (8 hours)

Aromatic & Heterocyclic Compounds: Structures of benzene, Theories of aromaticity, Electrophilic substitution reactions of benzene, Effect of substituents in electrophilic substitution, Structure, Preparation and electrophilic substitution reactions of Furan ,Thiophene and Pyrrole, Structure, Preparation, elctrophiic and nucleophilic substitutions of Pyridine, Preparation & Properties of quinoline and Indole (6 hours)

Dyes Chemistry: Colour and constitution, Chromophores, Auxochromes, Bathochromic and hypsochromic effects, Valence bond and molecular orbital approaches to color, UV & visible spectra of dyes, Classification of dyes according to applications and structures, Synthesis of Methyl orange, Cango red, Malachite green, Rosaniline, Alizarin, Fluoroscent brightening agents. (8 hours)

TEXT / REFERENCES:

- M.K. Jain, Modern Organic Chemistry, S.Chand & Co., Delhi, 1986
- L. Finar, Organic Chemistry, Vol I, 6th Edn, Longman, Delhi, 1977
- R.T. Morrson, R.N, Boyd, Organic Chemistry, 6th Edn., Prentice Hall, Delhi, 2003
- Arun Bahl, B.S.Bahl, Organic Chemistry, 18th Edn, S. Chand & Co., Delhi, 2006.
- Raj K.Bansal, Synthetic Approaches in Organic Chemistry, Jones & Bartlett
- Publishers.1996.

ORGANIC CHEMISTRY- II

ICH 232 3 - 0 - 0- 3

High Polymers: Classification of polymers, Degree of polymerization, Types of polymerization, Free radical mechanism of addition polymerization, Polymerization techniques: Bulk, Solution, Suspension and Emulsion polymerizations. Glass transition temperature, Molecular weights of polymers, Number average & weight average numerical problems, Methods of molecular weight determination, Viscosity, Ultracentrifugal methods, Stereoregular polymers, Structure – property relationship, Copolymerization, Graft, Block, random and alternative type, Significance of copolymerization equation and reactivity ratio.

Elastomers: Natural rubber, Processes for improvement of natural rubber, Vulcanization, Plasticizers, SBR, Butyl rubber, Nitrile rubber, Silicone rubber, Starch and Cellulose, Cellulose derivatives, Cuprammonium, Nitro, & Acetylation methods, Regenerated cellulose, Viscose, Ethyl, Methyl phthalate cellulose, Biopolymers.

Oils and Fats: Edible Oils, Saponification, Iodine and Acid values, Methods of their determination, Extraction of oils, Solvent extraction, Refining, Hydrogenation, Manufacture of

Vanaspati, Soaps and Detergents, Mechanism of cleansing action, Preparation of soaps, Liquid soaps, Synthetic detergents

Pharmaceutical and Petroleum Chemistry: Structure and chemistry of antibiotics, Penicillin, Streptomycin, Tetracycline, Chlorampenicol, Sulphadrugs, Antimalarials, Quinine, Production of penicillin, Petroleum production and classification, Refinery operations, Pyrolysis and cracking, Reforming, Polymerization, Alkylation, Isomerization, Vinyl chloride, Ethylene oxide, Isopropanol, Butadiene, Styrene, Phthalic anhydride

TEXT / REFERENCES:

- Kumar, R.K. Gupta, Fundamentals of Polymers, Tata McGraw Hill, New Delhi, 1998.
- M. G. Rao M. Sittig, Dryden's Outlines of Chemical Technology, 3rd edn, East West Press, New Delhi, 2010
- P. W. Kuchel, G. B. Ralston, Theory and Problems of Biochemistry, Mc Graw Hill, New York, 1988
- G.T. Austin, Shreve's chemical process industries, McGraw Hill, 5th ed, 1986
- G.E. Dryden, Outlines of Chemical Technology, East west press, 2nd ed., New Delhi, 1970

IV SEMESTER

IHS 241 – ENGINEERING ECONOMICS & MANAGEMENT

(Refer page no. **45**)

IBT 231 - BIOCHEMISTRY (Refer page no.**39**)

CHEMICAL REACTION ENGINEERING

ICHM 241 **3- 1 -0 –4**

Kinetics of homogeneous chemical reactions – Rate expressions – Temperature dependence of rate –Differential, integral, half-life and total pressure method –theories, Elementary and Non elementary reaction kinetics - Pseudo, steady state hypothesis – mechanism.

Isothermal reactor design – Design of batch, CSTR's and PFR's – Problems on optimization, Multiple reactor systems – Reactors in series or/and parallel combinations – CSTRs series – Performance analysis –Batch, Continuous and Recycle reactors.

Multiple reaction system – Series and parallel reactions in flow reactors - Product distribution – Yield and selectivity – Maximizing the desired product

Non-ideal reactor- types of non-idealities, determination of non-idealities by RTD studies

Introduction to non-isothermal and heterogenous reactions.

TEXT / REFERENCES:

- Scott Fogler H, Elements of Chemical Reaction Engineering, (4e), PHI, 2005.
- Octave Levenspiel, Chemical Reaction Engineering, (3e), Wiley & Sons, 2003.
- Rawlings J.B, Ekerd, J.G., Chemical Reactor Analysis and Design Fundamentals Nole Hill 2002.
- Smith J.M, Chemical Engineering Kinetics, (3e), McGrawl-Hill, International student edition.

HEAT TRANSFER OPERATIONS

ICHM 242 **3- 0 -6 –5**

Modes of heat transfer - Steady state conduction – Development of equations for conduction through plane, curved surfaces - Compound resistances - Variation of thermal conductivity with temperature – Derivations for plane wall and curved surfaces - Insulation – Critical thickness of insulation – Heat transfer with internal heat generation – Introduction to transient conduction

Heat Transfer by convection – Types - Natural and Forced convection – Factors influencing heat transfer coefficients – Analogies – Enthalpy balances in an exchanger - Heat Transfer with packed and fluidized bed - Heat transfer in extended surfaces – Fin efficiency, Fin effectiveness.

Heat Exchangers – concept of logarithmic mean temperature difference and overall heat transfer coefficient – dirt factor. Heat exchanger effectiveness. Heat transfer with phase change – Heat transfer to boiling liquids – Types of condensation – Nusselt equation derivation.

Radiation heat transfer – Kirchoff's law – view factor – calculations – radiation exchange between gray bodies – Radiation shield – Net radiation between two parallel planes – Temperature measurement of gases and radiation errors.

TEXT / REFERENCES:

- J.M. Coulson and J.F. Richardson – Chemical Engineering, Vol.1, 6th ed., Elsevier India private limited , 2006.
- Kreith- Principles of Heat Transfer, Delmer learning India private limited, 6th Edition, 2007
- McCabe and Smith- Unit Operations in Chemical Engg., McGraw Hill Co., 7th edition, 2005.
- Kern D.Q., Process Heat Transfer, McGraw Hill Co., 1st edition, 2009.
- Mc Adams- Heat Transmission, 3rd edition, McGraw Hill Co., 5, 1950.
- Gupta and Prakash, Engg. Heat Transfer, Nemchand, 7th edition, 1999.
- M. Jacob- Heat Transfer, Vol.2, John Wiley & Sons, 1958

HEAT TRANSFER OPERATIONS LAB:

The experiments are conducted and mini project can be given based on the following topics:
Transient Heat Conduction, Combined Convection And Radiation Heat Transfer, Heat Transfer In A Double Pipe Heat Exchanger, Heat Transfer In A Vertical Shell And Tube Condensor, Heat Transfer In A Horizontal Shell And Tube Condensor, Condensation In Finned Tube Heat Exchanger, Heat Transfer In Bare Tube Heat Exchanger, Forced Convection Heat Transfer In Jacketed Vessel, Pool Boiling, Boiling Point Regime – Determination of Heat Transfer Coefficient, Thermal conductivity of the copper rod, Packed Bed Heat Exchanger

MASS TRASFER - I

ICHM 243 **3- 0 -0 –3**

Diffusion: Introduction to mass transfer operations- molecular diffusion in gases and liquids-steady state diffusion under stagnant and laminar flow conditions−diffusion in multi component mixtures−Diffusion in solids−molecular and Knudsen diffusion in porous solids−unsteady state diffusion in solids.

Interphase Mass Transfer and Mass Transfer coefficient: Theories of interphase mass transfer-estimation of mass transfer coefficient - Individual and overall mass transfer coefficients for gas-liquid and liquid-liquid operations−Material balance approach for steady state mass transfer processes−concept of equilibrium curve and operating line−stages and Murphree stage efficiency.

Absorption: Gas Absorption−calculation of number of theoretical stages for Absorption and stripping column (Graphical)−estimation of number of plates by Kremser equation−Packed tower absorber – HETP−HTU and NTU calculations – Design of absorption column−Equipment for gas-liquid operations.

Adsorption: Adsorption−adsorption isotherm−batch and continuous stage wise adsorption operation−unsteady state fixed bed adsorbers−break through curves - process design of adsorption column- Adsorption equipment.

Humidification and Dehumidification: Vapor gas mixtures terminology – Psychometric chart – Water cooling operations–Gas-Liquid contact operations–Adiabatic operations–Types of Equipment – Design calculations – Cooling towers –design of cooling towers–Recirculating Liquid-gas humidification cooling

TEXT / REFERENCES:

- R.E. Treybol, “Mass Transfer Operations”, McGraw Hill, II Edition, 1981.
- Foust, A.S.Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., “Principles of Unit
- Operations ", Second Edition, Wiley,1980.
- W.L.Mc.Cabe, J.C.Smith and P.Harriot, “Unit operations of chemical engineers”, McGraw Hill International edition, V edition, 1995.
- C.J.Geankoplis, “Transport Processes and Unit Operations”, Prentice Hall, III Edition, 1993.
- Coulson J.M and Richerdson J.F,“Chemical Engineering - Volume 2” Elsevier Press,VthEdition,2006.
- Principles of mass transfer and separation processes, B.K. Dutta, PHI, India.

INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

ICH 241 **3- 0 -0 –3**

Electroanalytical Methods: Conductometric Titrations, The basic principles of conductometric titrations, Applications of conductometric titrations-Strong acids with strong bases, weak acids with strong bases, weak acid with weak bases and strong acid with weak bases, Mixture of strong and weak acids with strong base, Precipitation Titrations, Potentiometry-Electrode potential, Direct potentiometry, Indicator electrode, Reference electrode, Glass electrode, Assymetric potential, acid error and alkaline error, Ion selective electrode, Potentiometric

Titrations, Principle, Location of end points, Neutralisation titration, Oxidation reduction Titrations, Precipitation titration.

Spectroanalytical Methods: Rotational Spectroscopy, Theory: Rigid diatomic molecules, Non-rigid diatomic molecules, Instrumentation, Applications. IR Spectroscopy: Theory-Molecule as a simple Harmonic Oscillator and anharmonic oscillator, Rotational- Vibrational Spectra of a diatomic molecules, Modes of vibrations of atoms in polytomic molecules, Instrumentation (double beam IR Spectrophotometer), Applications, Raman Spectroscopy: Mechanism of Raman effects, Classical and quantum theories, Applications. UV-Visible spectroscopy: Theory- Types of transitions in organic molecules, Instrumentation (Double beam spectrophotometer), Application-qualitative and quantitative, Spectrophotometry, Beer-Lamberts Law and its deviations

Thermal methods: Theory, Instrumentation (double beam spectrophotometer) Interference, applications, Thermal Analysis: Thermal methods of Analysis, Thermogravimetry Thermogram. Factors affecting Instrumentation, Application, Derivative Thermal Gravimetry{DTG}, Differential Thermal Analysis. (DTA) Factors affecting DTA, Instrumentation and Applications

Chromatography: Introduction, Classification, Thin layer chromatography, Experimental Techniques. Gas chromatography, Instrumentation, Carrier gas, Sample injection system, Columns, Detectors-Important properties, Thermal conductivity detector, Flame ionization detector, Electron Capture detectors. Temperature control, Evaluation, Retention volume. Resolution, Qualitative and quantitative Applications, Liquid Chromatography, Column efficiency of liquid Chromatography, High performance liquid chromatography, Instrumentation and applications

TEXT / REFERENCES:

- Vogel's Text Book of Quantitative Analysis 5th edn. ELBS, Longman, 1991
- G. Chatwal, S. Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House, New Delhi, 2000
- H.H. Willard, L.L. Merrit, J.A. Dean, Instrumental Methods of Analysis, 6th edn, CBS Publishers, Delhi, 1986
- C.N. Banwell, Fundamentals of Molecular Spectra, TMH, 3rd edn. Tata McGraw Hill, New Delhi, 1994
- D.A. Skoog, J.J. Leary,"Principles of Instrumental Analysis", Sounders College Publishing, 4th Edn, 1992.

V SEMESTER

PROJECT WORK

ICHM 351 **0-0-36-12**

Students need to form batches with maximum four in numbers and required to identify the problem in their area of interest within their discipline of study under the supervision of a faculty (Guide) for 12 to 14 weeks. At the end, the findings need to be presented in the form of a project report for final evaluation.

VI SEMESTER

CHEMICAL PROCESS INDUSTRIES

ICHM 361 **3-1-0-4**

Indian industry – A brief review - Detailed description of the processes along with neat flow diagrams, engineering problems that are encountered frequently during the process and major uses and application are to be discussed for the following.
Industrial gases: Carbon dioxide – Hydrogen – Oxygen – Nitrogen – Synthesis gas
Chloroalkali industry: Common salt – Caustic soda – Chlorine – Hydrochloric acid – Bleaching powder – Soda ash
Sulfur and sulfuric acid: Extraction of sulfur – Production of sulfuric acid from sulfur and other sources – Recent advances
Fertiliser industry: Ammonia – Nitric acid – Ammonium nitrate – Ammonium sulfate – Ammonium chloride – Urea
Phosphate industry: Elemental Phosphorous – Phosphoric acid – Superphosphates – NPK fertilizers
Oils, fats and waxes: Edible oils – Extraction of vegetable oil – Hydrogenation of oil – Soaps and detergents – Manufacturing processes – Glycerin recovery
Pulp and paper: Chemical and mechanical pulp – Pulping methods – Chemical recovery of black liquor – Paper and paper board
Sugar and starch: Sugar – Starch and modified starches – Glucose – Fermentation – Media for growth - Industrial alcohol – Absolute alcohol – Acetone and Butanol
Polymerisation: Classification of polymers – Modes of polymerization – Polyvinyl chloride – Polyethylene – Viscose rayon , Nylon 6 and Nylon 66 – Natural and synthetic rubber

TEXT / REFERENCES:

- Faith Keyes, et.al, Industrial Chemicals, (4e), Wiley Interscience, 1975.
- Charles E Dryden, Outlines of Chemical Technology, (2e), East Press Ltd., 1975.
- CHEM TECH – Vol 1 – 4, Chemical Engineering Education Development Centre, IIT, Madras, 1975 –78.
- Austin G.T., Shreve's Chemical Process Industries, (5e), McGraw-Hill, 1986.

MASS TRANSFER - II

ICHM 362 **3-1-3-5**

Distillation: vapour liquid equilibrium concept - Raoults law - deviations from ideal law - concept of azeotropic and types – steam distillation – Enthalpy concentration diagrams – binary and multi component systems – dew and bubble point calculations – flash vaporization – simple distillation-binary component distillation - continuous rectification – methods for identifying the theoretical trays: 1) PonchanSavarit method: minimum reflux ratio, optimum reflux ratio- total reflux ratio, partial condenser, total condenser, 2) McCabe – Thiele method: concept of q line, optimum reflux ratio- total reflux ratio, partial condenser, total condenser. Multi component distillation: azeotropic, extractive, molecular distillation.

Liquid-Liquid Extraction: liquid-Liquid-Equilibria- Ternary systems – triangular and rectangular coordinates-choice of solvent-single stage and multi stage cross current, equipment's such as mixer settler, packed and tray towers.

Leaching: Concept of Leaching, effect of temperature and size of feed on leaching, Batch leaching processes.

Drying – Theory, Types and mechanism of drying operation – Hysteresis – Rate curves – Batch and continuous drying–Direct and indirect drying – Through circulation drying – Industrial dryers – Design criteria – Design of rotary dryers

Recent advances in mass transfer operations: Introduction to membrane process- advantages-disadvantages- types membranes – preparation of membrane-pore measuring techniques

TEXT / REFERENCES:

- R.E. Treybal, Mass Transfer operation, McGraw-Hil, 1968
- McCabe and Smith, Unit Operations of Chemical Engineering, (5e), McGraw-Hill 1993
- Coulson-Richardson, Chemical Engineering –Vol-II, Paragmon and ELBS, 1970
- Kausik Nath, Membrane separation process

MASS TRANSFER LABORATORY:

The experiments are conducted based on the following topics:
Applicability of Rayleigh's equation for simple distillation – vaporization and thermal efficiency of steam distillation – distillation under total reflux in a packed column – studies in batch adsorption – diffusivity by stephen's method – mass transfer coefficient in dissolution of solid – liquid-liquid extraction in a three stage cross flow cascade operation – studies in simple and cross flow leaching – experimental determination of liquid-liquid equilibrium data – drying of solids in fluidized bed dryer – extraction of solute in packed bed column – crystallization process in an batch crystallizer – tray efficiency of bubble cap distillation column – vapour-liquid composition of the liquid in an experimental setup.

ELECTIVE – I

ICHM 363 **3-0-0-3**

PETROCHEMICALS:

General introduction – Economics and future prospects of petrochemicals – Energy crisis and petrochemical industry – Sources and classification of petrochemicals

First generation petrochemicals – Alkanes – Alkenes and alkynes – BTX aromatics – Diene base petrochemicals

Second generation petrochemicals – Synthesis gas – Methanol – Formaldehyde – Chloromethanes – Ethanol – Acetaldehyde – Acetic acid – Acetic anhydride – Isopropyl alcohol – Ethylene oxide – Propylene oxide – Acetone – Vinyl chloride – Phenol – Aniline – Styrene

Third generation petrochemicals – Plastics – Rubber – fibres – olefinic polymers – Polyethylene – Polypropylene – Poly-isobutylene – Diene polymers – Polybutadiene – Neoprene – Polyisoprene – SBR – Synthetic fibres

TEXT / REFERENCES:

- Maiti, S., Introduction to Petrochemicals, Oxford and IBH Publishing Co. Ltd., 1992
- Chem Tech IV, Chemical Engineering Education Development Centre, IIT Madras, 1978.
- Austin, G., Shreve's Chemical Process Industries, (5e), McGraw-Hill, NY, 1986

INDUSTRIAL WASTEWATER ENGINEERING:

Introduction to waste water engineering, Standards for treated waters, Algae, Control measures, quality of underground Waters. Nature and source of impurities. Examination of waters. Requirements of water treatment facilities. Purpose of advanced wastewater treatment, Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation. Kinetics of biological growth, introduction to suspended and fixed film reactors. Concepts of gas transfer and solids separation, Nitrogen and Phosphorus removal from waste water. Concepts of aerobic and anaerobic treatment of waste water.Design of Activated Sludge system using biological process dynamics. Complete design details of Activated Sludge Process. Modifications of ASP. Process concepts and design aspects of Trickling Filters, Rotating Biological Contactors (RBC), Fluidized bed reactor/treatment. Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying. Advance waste water treatment processes, sludge treatment and disposal

TEXT / REFERENCES:

- Templeton M R, Butler D, Introduction to Wastewater Treatment (e-book)
- Metcalf, Eddy,Wastewater Engineering - Treatment and Reuse, (4e),McGraw-Hill, 2003
- ViessmanW, Hammer M J, Water Supply and Pollution Control, (6e),Addison Wesley, 1998
- Hendricks D, Fundamentals of Water Treatment Unit Processes, CRCPress/IWAPublishing, 2011
- Peavy H S, Rowe D R, Tchobanoglous G, Environmental Engineering, McGraw-Hill, 1985

ELECTIVE - II

ICHM 364 **3-0-0-3**

PETROLEUM REFINERY ENGINEERING:

Origin, Formation, Migration & Accumulation of petroleum, Exploration, Drilling, Well completion, Recovery (primary, secondary & tertiary), Separation and Transportation; Indian refining scenario, OPEC and WPC; Crude oil composition, Characterization and classification; Atmospheric and vacuum distillation, Design of crude oil distillation columns; Thermal Cracking, Visbreaking, Coking; Catalytic cracking and hydro cracking: principles, feedstocks, technologies, catalyst, operational conditions, products etc.; Catalytic reforming: principles, feedstocks, technologies, catalysts, operational conditions, products etc.; Isomerization, Alkylation and Polymerization; Refinery Products, Tests and specifications, Treatment of petroleum products, Hydro desulfurization, Product blending; Lube oil processing: De

asphalting, solvent extraction and de-waxing; Energy conservation in petroleum refineries; Environmental issues and New Trends in petroleum refinery operations

TEXT / REFERENCES:

- James G Speight, The chemistry and technology of petroleum, (4e), CRC Press, 2006
- R A Meyers, Handbook of petroleum refining processes, (3e), McGraw-Hill, 2004
- B K BhaskaraRao, Modern petroleum refining processes, (5e), Oxford& IBH, 1984
- Nelson, Petroleum refining engineering, McGraw-Hill, 1949
- R N Watkins, Petroleum refinery distillation, Gulf publication, 1979

POLLUTION CONTROL ENGINEERING:

Man and environment – Nutrient and hydrologic cycles – Types of pollution – Legislation to environmental pollution – Aspects of pollution control
Evaluation and characterization of wastewater – Treatment methods – Advanced wastewater treatment – Sludge treatment and disposal – Solid waste management
Noise pollution and control
Ambient and stack gas sampling – analysis of air pollutants – Principles of air pollution – Plume behavior – Meteorological factors affecting air pollution – Equipments for control and abatement of air pollution
Pollution control of effluent in chemical industries such as Fertilizer, Petroleum refinery, Pulp and paper and Tannery industries

TEXT / REFERENCES:

- S.P. Mahajan, Pollution Control in Process Industries, Tata McGraw Hill, 2008
- C.S. Rao, Environmental Pollution Control Engineering, (2e),New Age International Publishers, 2006
- V Cavaseno, Industrial Air Pollution Engineering, (1e), McGraw Hill, NY, 1980

ELECTIVE - III

ICHM 365 **3-0-0-3**

SOLID WASTE ENGINEERING AND MANAGEMENT:

Sources, quantities generated, and physiochemical properties of municipal solid waste and hazardous waste, Solid Waste Management Pyramid – Key Technologies for SWM (collection, handling, transformation, landfills, incinerators, composting); Relevant environmental regulations for waste disposal, site investigations; Site Selection (NIMBY), Regulatory permitting process; Incineration, composting, Types of Landfills, basic geotechnical considerations, earthen liners for waste disposal, Clay mineralogy, factors controlling hydraulic conductivity, methods to measure k in the lab and field, compatibility of liner materials to chemicals in leachate, Operational aspects of MSW landfills (daily cover, leachate disposal, GW monitoring), Landfill Gas Collection System and Leachate Recirculation System Design, Landfill Final Cap Design and Water Balance Modeling

TEXT / REFERENCES:

- Tchobanoglous, Getal, Integrated Solid Waste Management, (2e), McGraw Hill New York, 2001
- LaGrega, Mi, Bucking ham P, Evans, J,Hazardous Waste Management, (2e), McGraw Hill, 2001
- McBean E, Rovers F, Farquhar G,*Solid Waste landfill Engineering and Design, (1e),* PHI, New York, 1995

OIL AND GAS RESERVOIR ENGINEERING:

Basic concepts of reservoir engineering: Calculation of hydrocarbon volume, Fluid pressure regimes, Recovery factor, Hydrocarbon phase behavior.
PVT analysis for oil, gas and water: Definition of parameters, Fluid sampling, Laboratory testing and conversion to field conditions.
Material balance applied to oil reservoirs: General form of equation, Reservoir drive mechanisms, Solution gas drive, Gas cap drive, Natural water drive.
Flow through porous media: Darcy's law, Flow regimes, Real gas potential, Flow geometry and pressure distribution, Radial flow equation, Multiphase flow: effective and relative permeability, solution of radial flow equation; transient flow analysis, stabilized deliverability, calculation of water influx.
Oil Well Testing: The constant terminal rate solution for transient and steady state flow, Superposition theories, Pressure build-up theory and analysis, Well-completion.
Gas Well Testing: Radial flow of a real gas, Solution techniques of radial flow equation, Theory of gas well testing, Pressure build-up and analysis techniques
Natural Water Influx and Immiscible Displacement: Water influx theory and prediction of water influx, Oil recovery calculations, Displacement under different conditions.
Reservoir Simulation: Classical reservoir engineering and reservoir simulation, Effects of variable properties, Capillary pressure and flow.

TEXT / REFERENCES:

- Dake L P, Fundamental of Reservoir Engineering, Elsevier.1978.
- Smith H C, Tracy G W, Farrar R L, Applied Reservoir Engineering: VolI and II, OGCI. 1999
- Tarek Ahmed, Reservoir Engineering Handbook, (2e),Gulf Professional Publishing, 2001
- Salter A, Baldwin J, Jespersen R, Computer-Aided Reservoir Management,Pennwell. 2000.

ELECTIVE - IV

ICHM 366 **3-0-0-3**

AIR POLLUTION CONTROL AND EQUPMENT DESIGN:

Meteorological aspects of air pollution dispersion; Air pollution sampling and measurements; Air pollution control methods and design of Equipments: Settling chambers, laminar and turbulent flow – Filtration, Collection of particles by cylindrical fibers and granular beds – Electrostatic precipitation – Cyclones – Wet collectors; Efficiency and dimensions of particle control devices; Gas absorption in tray and packed towers, Stage efficiency, Equilibrium number of stages/packed height; Absorption with/without chemical reaction. Advanced

techniques for Removal of SO2 and CO2; Removal of HCs/VOCs; NOx removal from effluent streams.

TEXT / REFERENCES:

- Martin Crawford, Pollution Control Theory, McGraw Hill, NY. 1976.
- Joe Ledbetter, Air Pollution Part A&B, Marcel Dekker, NY, 1972.
- A.C Perkin, Air Pollution, McGraw-Hill 1974.
- S.M. Khopkar, Environmental pollution Monitoring and control, New Age Int. ND, 2004.

PROJECT ENGINEERING:

Preliminary data on projects; Process engineering, Block flow diagram, Process flow diagram, Piping and instrumentation diagram, Pilot plants, General considerations for plant location and layout, piping design, plant utilities, insulation, instrumentation, safety in chemical plant, Project engineering management, Project scheduling and its importance, PERT and CPM techniques, Gantt chart, Optimum project design, optimum production rates, selected examples such as heat exchangers, pumps , vessels, evaporators, and driers.

TEXT / REFERENCES:

- Howard F. Rase, M.H. Barrow, Project Engineering of Process Plants, John Wiley, 1957
- Warren Sieder, J.D. Seader, Daniel Lewin, Product and Process Design Principles, John Wiley, 2004
- Gael D.Ulrich, A Guide to Chemical Engineering Process Design and Economics, John Wiley, 1984
- Max S Peters, Klaus D. Timmerhaus, Ronald E. West, Plant Design and Economics for Chemical Engineers, McGraw- Hill, 2003
- E.E. Ludwig, Applied Project Engineering, Gulf Publishing Co., Houston, 1988
- J.Modes, Philips, Project Engineering with CPM & PERT, Renhold Publishing Co.
- Coulson and Richardson's Chemical Engineering Series Chemical Engineering Volume 6, Chemical Engineering Design, (3e), 2003

SEMINAR

ICHM 367 **0-0-3-1**

Students need to present a seminar on a topic of recent developments in their subject filed.

B.Sc. (CIVIL)

II SEMESTER

IMA 121 – MATHEMATICS - II (Refer page no.**33**)
IPH 121 – PHYSICS - II (Refer page no.**33**)
ICH 121 - CHEMISTRY (Refer page no.**35**)
IME 121 – ENGINEERING GRAPHICS - II (Refer page no.**36**)

BUILDING SCIENCE & TECHNOLOGY

ICE 121 **3-1-0-4**

Cement: Types, composition, properties and uses, physical tests on cement as Per I.S. (4 hours)

Concrete Technology: Concrete: Definition, ingredients: coarse aggregate, fine aggregate, water, properties, tests as per IS, Water-cement ratio. Fresh Concrete: Mix design proportion-batching-workability mixing, placing, compacting, various methods of curing, Test on Fresh concrete as per IS. Shrinkage of Concrete. Hardened Concrete: Deformation Characteristics and Mechanical properties. (13 hours)

Introduction to Alternative Concretes: High Strength/Performance Concrete, Roller Compacted Concrete, Self-Compacting Concrete, Reactive Powder Concrete, Polymer Concrete, Slurry infiltrated fibrous concrete(SIFCON), Slurry Infiltrated Mat Concrete (SIMCON) (2 hours)

Bricks: chemical composition, classification, and applications. Tests on bricks Refractory and modular bricks. (2 hours)

Timber: properties, defects, seasoning and preservation, plywood-Types and uses. (2 hours)

Roofs: Sloped roofs - Lean-to, Coupled and Collared roofs. (2 hours)

Tiles: Roofing, Flooring ,and decorative Tiles – Mechanical Properties and uses of Tiles, Lime – Types, properties and uses (2 hours)

Modern Building Materials: Plastic, FRP, rubber, glass, ferro-cement, glass, ceramics, paints, distemper, varnishes-Definitions and applications. (4 hours)

Masonry elements: Mortar, Lime mortar, Cement mortar, bonds in brickwork, Reinforced brickwork. (3 hours)

Stone masonry: coursed, rubble and ashlar stone masonry, Joints in masonry, Hollow block construction. Rat trap masonry, Load bearing and partition walls. Damp proof construction for walls and floors. Masonry arches. (4 hours)

Plastering, Painting and Flooring: Wall plastering: types, properties. White washing, Colour washing and Distempering of walls. Plastic emulsion, enamel and powder coat painting of

walls. Painting of wood and metal works. Granolithic, Concrete, Ceramic, Marble, Terrazzo and Synthetic material flooring: Definitions (5 hours)

Tar, Bitumen and Asphalt: Properties and uses. (2 hours)

Shoring, Underpinning, and Scaffolding. (3 hours)

TEXT/ REFERENCES:

- Neville A. M, (1989), "Properties of Concrete", McGraw Hill- Singapore.
- SP 20-1991 Handbook on Masonry design and construction
- SP10-1975 Nomograms for thickness of masonry walls (First reprint September 1991)
- SP:62 (S&T) :1997 Handbook on Building Construction Practices.
- "National Building Code", (1988), BIS, New Delhi
- Punmia B.C, (2003), "Building Construction", Lakshmi Publications, New Delhi.
- Sushil Kumar, (1976) "Building Construction", Standard Publication
- Mohan Rai and Jai Singh M.P, (1986) "Advances in Building Material and Construction" CBRI Publications, Roorkee.
- Shetty M.S., (2006), "Concrete Technology", S. Chand and Co., New Delhi.
- ITTI, (2003), "Engineering Materials", Tata McGraw – Hill Publishing Co., Ltd., New Delhi.

MECHANICS OF STRUCTURES

ICE 122 **3-1-0-4**

Introduction: Overview and Scope of the subject (1 hour)

Analysis of Determinate Trusses: Plane trusses- method of joints and method of sections (5 hours)

Bending moment and shear force diagram: for statically determinate beams (6 hours)

Bending and shear stresses: Determination of bending and shear stresses in statically determinate beams of various cross sections (5 hours)

Torsion of circular shaft: Simple torsion theory, solid and hollow circular shafts, power transmitted by shafts (4 hours)

Stability of columns: Slenderness ratio, failure by buckling, Euler's formula, concept of equivalent length for different support conditions, limitation of Euler's formula, Rankine-Girdon Formula (4 hours)

Stress on inclined planes: principal stresses and their planes. (4 hours)

Analysis of Arches and suspension bridge: Analysis of three hinged parabolic and segmental arches. Determination of horizontal reaction, normal thrust, radial shear and bending moment. Analysis of suspension bridge with three hinged stiffening girder. (6 hours)

Strain Energy: Strain energy due to axial force, shearing force, bending moment and twisting moment. Law of conservation of energy, virtual work on rigid and elastic bodies, Betti's theorem, Maxwell's law of reciprocal deflections, Castigliano's theorems. (3 hours)

Deflection: Determination of deflection in beams and simple frames by strain energy methods- Unit load method and Castigliano's method. Determination of deflection in statically determinate beams using Mecaulay's method (10 hours)

TEXT/ REFERENCES:

- Timoshenko, Strength of Materials Vol. I & Vol. II , CBS Publishers & Distributers, New Delhi
- James M Gere & Stephen P Timoshenko , Mechanics of Materials , CBS Publishers &Distributers, New Delhi
- Basavarajaiah & Mahadevappa, Strength of Materials, CBS Publishers.
- Reddy C.S., Basic structural analysis, Tata McGraw Hill, New Delhi.
- Ramamrutham & Narayanan, Strength of Materials, Dhanpat Rai

III SEMESTER

IMA 231 - MATHEMATICS - III (Refer page no.**39**)

BASIC REINFORCED CONCRETE DESIGN

ICE 231 **3 - 1 - 0- 4**

Elements of RCC: Role of reinforcement, behavior of RCC section. Straight line Theory- Assumptions, determination of Neutral axis, determination of stress and strain due to bending moment – Singly reinforced and doubly reinforced sections. (8 hours)

Determination of short term and long term deflections of R.C. beams, Determination of Crack width. (6 hours)

Limit state method: principle of limit state method of design, characteristic loads, characteristic strength and partial safety factors. Stress strain characteristics for concrete and steel. (2 hours)

Introduction to stress block parameters for collapse, limit state of serviceability. (2 hours)

Limit state method of design of beams- Design of rectangular beams (singly and doubly reinforced), flanged beams (6 hours)

Limit state design and detailing of RCC member - for development length, shear and torsion (6 hours)

Limit State Design of one way and two way slabs for various boundary conditions. (6 hours)

Limit State of Collapse in compression, Design of axially loaded short R.C. columns, uniaxial and Biaxial bending – use of interaction diagram. Design of slender columns, effective length of columns – using SP16 hand book (8 hours)

Design of footing – loads on foundation – Design basis (limit state method).
Introduction to pre-cast, pre-stressed concrete (4 hours)

TEXT / REFERENCES:

- Shah H.J. " Reinforced Concrete" Vol I, Charotar Publishing house.
- Sinha N.C. and Roy S.K " Fundamental of Reinforced Concrete" S. Chand and company.
- Jain A.K. " Reinforced Concrete- limit state design".
- Karve S.R, and Shah V.L., (1996), "Limit State Theory and Design of Reinforced Concrete", Structures Publishers, Pune.
- Varghese P.C., (1999), "Limit State Design of Reinforced Concrete", Prentice Hall of India,New Delhi.
- Unnikrishna Pillai,Devdas Menon(1998),"Reinforced Concrete Design" Tata McGraw Hill
- Publishing Company Limited, New Delhi
- SP-16-1980 Design Aids for Reinforced Concrete IS 456-1978
- IS 456-2000 code of practice for plain and reinforced concrete.
- SP 24 : 1983, Explanatory hand book on I S code of practice for plain and reinforced concrete.

FLUID MECHANICS

ICE 232 3 - 1 - 0- 4

Introduction: Scope and importance of the subject. Definition of fluid - Distinction between a solid and a fluid - Distinction between a liquid and a gas - fluid continuum

(2 hours)

Fluid Properties and Classification of Fluids : Specific weight, mass density, specific volume, specific gravity, viscosity, compressibility, vapour pressure, surface tension and capillarity and their units, dimensions and significance. Classification of fluids - Ideal and Real fluids, Newtonian and Non - Newtonian fluids, Compressible and Incompressible fluids.

(5 hours)

Fluid Pressure and its Measurement: Pressure at a point in a static fluid - Pascal law - Atmospheric, absolute, gauge and vacuum pressures. Pressure measurement – simple, differential & compound manometers; Mechanical pressure gauges (Bourdon Pressure gauge only) (4 hours)

Hydrostatics: Forces on plane surfaces - Horizontal, vertical and inclined surfaces, Forces on curved surfaces, center of pressure on plane and curved surfaces, Drawing pressure distribution diagrams & its Applications. (4 hours)

Kinematics of Fluid Motion: Introduction, methods of describing fluid motion - Lagrangian and Eulerian approach - classification of flow - steady flow and unsteady flow, uniform flow and Non - uniform flow, laminar and turbulent flow, compressible and incompressible flow, three, two and one dimensional flow, Rotational flow and Irrotational flow - stream line, pathline, streak line and stream tube, Acceleration in one dimensional flow - continuity equation in differential form in Cartesian co-ordinates - continuity Equation for one dimensional flow (Integral form). (4 hours)

Dynamics of Fluid Motion: Euler's Equation of motion; Bernoulli's Equation, limitations, modification, applications of Bernoulli's Equation, Venturimeter, Orifice meter, Pitot tube.

(4 hours)

Ideal Fluid Flow: Requirements for ideal fluid flow, Rotational and Irrotational flows – Velocity Potential Functions, Stream Function, Flow nets. (4 hours)

Laminar Flow Through Pipes: Reynold's Experiment, steady laminar flow through a circular pipe, Relation between pipe friction factor and Reynold's Number. (3 hours)

Turbulent Flow Through Pipes: Head loss due to friction - Darcy Weisbach Equation; Minor losses in pipe lines; pipes in series and pipes in parallel. Concept of equivalent pipe, equivalent length - pipe siphons - Hydraulic and Energy gradients. Water hammer in pipes- pressure rise in a pipe due to gradual and sudden closure of valves. (5 hours)

Flow Measurement: Flow under constant head - Orifices and Mouth Pieces. Classification of orifice and mouth pieces, Hydraulic coefficients and their determination - Flow through notches and weirs - Rectangular, Triangular, Trapezoidal and Cippoletti notches; Broad crested weir, Open spillway and Siphon spillway; Flow under variable head – Time of emptying and filling of tanks through orifices. (5 hours)

Flow in open Channels: Introduction to free surface flows - Geometric elements; Types of open channel flows. Chezy's and Manning's formulas, hydraulically efficient channel cross section – Rectangular and Trapezoidal channels; Specific energy, specific energy curve, critical depth, alternate depth, critical flow in rectangular channels, Froude's Number, its significance; Hydraulic jump in rectangular channels - Sequent depth, Loss of energy. (8 hours)

TEXT / REFERENCES:

- Streeter V.L. and Wiley E.B., (1998), "Fluid Mechanics", McGraw Hill book Co., New York.
- Modi P.N. and Seth S.M. (2005), "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi.
- Bansal R. K. (2010), "Fluid Mechanics and Hydraulic Machines", Laxmi Publishers, New Delhi.
- Jain A.K., (2002), "Fluid Mechanics", Khanna Publishers, New Delhi.
- Garde R.J., (2003), "Fluid Mechanics through problems", New age international Pvt. Ltd., Publishing, New Delhi.

GEOTECHNICAL ENGINEERING

ICE 233 **3 - 1 - 0- 4**

Introduction: Origin & formation of Soil: Types, Typical Indian Soil, Fundamental of Soil Structure, Clay Mineralogy. (5 hours)

Physical & Index properties of soil: Soil as a three phase system, Physical properties of Soil and Laboratory Determination - Specific gravity, Void ratio, Porosity, Degree of saturation, Bulk density, Dry density, Saturated density, Relative density, Moisture content, Inter - relationships between them Atterberg's limits, Sieve Analysis, Hydrometer analysis. (8 hours)

Classification and Compaction of soil: Field identification of soil, IS Classification of soil, Soil compaction – Theory, laboratory determination of Maximum Dry Density and Optimum Moisture Content, Factors influencing compaction behavior of soils. Equipment's for compaction control in the field, field compaction methods. (6hours)

Flow through soil: Darcy's Law, Coefficient of permeability, laboratory determination of coefficient of permeability, Permeability for Stratified Deposits, Soil water – static pressure in water – Effective stress concepts in soils – capillary stress, Quicksand condition, Seepage – introduction to flow nets. (9hours)

Stress distribution: Boussinesq's theory, Stress due to point loads & uniformly loaded circular area & rectangular area, pressure bulbs, Use of Newmark's charts. (4 hours)

Compressibility & Consolidation of Soil: Components of settlement — immediate and consolidation settlement – Terzaghi‟s one dimensional consolidation theory (no derivation) Oedometer test, √t and log t methods– e-log p relationship – Normally Consolidated, Over and Under consolidated soils. (8 hours)

Shear Strength of Soil: Concept of shear strength of soils, Mohr-Coulomb theory and failure criteria, Laboratory determination of shear strength parameters - Direct shear, Triaxial, Unconfined compression and Vane shear tests, Drained, Undrained and consolidated undrained tests and their applications. (8 hours)

TEXT / REFERENCES:

- Terzaghi K., and Peck R.B., (1967), "Soil Mechanics in Engineering Practice", A Wiley International Edition, 2nd Edition, New York.
- Taylor D.W., (1960), "Fundamentals of Soil mechanics", Asia Publishing house Bombay, 3rd Edition.
- Ramiah B.K. and Chickanagappa L.S., (1990),"Hand Book of Soil Mechanics and Foundation Engg.", Oxford and IBH, 2nd Edition.
- Lambe T.W. and Whitman R.V., (1987), "Soil Mechanics", SI Version, John Wiley and Sons.
- Punmia B.C,.(2005), "Soil Mechanics and Foundations", Laxmi Publications Pvt. Ltd., 16th edition.
- Arora K.R, (2008), "Soil Mechanics and Foundation Engineering", Standard, Publishers and Distributors, 7th Edition.
- Murthy V.N.S., (1995), "A Text Book of Soil Mechanics and Foundation
- Engineering", SaiKripa, Technical Consultant, Bangalore, 3rd Edition.
- GopalRanjan and. Rao A.S.R, (2000), "Basic and Applied Soil Mechanics", New Age International Pvt. Limited, Publishers, 2nd Edition.

SURVEYING

ICE 234 **3 - 1 - 0- 4**

Introduction: Introduction of surveying, objectives, classification, principles of surveying. (2 hours).

Leveling: Definitions of terms, levelling instruments. Temporary and permanent adjustments of levels. Terms: Station, height of instrument, back sight, intermediate sight, fore sight, change point.

Methods of levelling - Differential, profile, cross sectioning reciprocal and trigonometric levelling.

Sensitivity of bubble tube, curvature and refraction effects. Methods of booking, errors in levelling. (10 hours)

Theodolite: Function of various parts. Temporary and permanent adjustments.

Measurement of horizontal and vertical angles, setting out centre line of roads, buildings

(4 hours)

Tacheometry: Principles, methods - analytic tacheometer - distance and elevation formulae for horizontal and inclined site with staff vertical and normal - Beaman's stadia arc - range finder.
(8 hours)

Contours - Contour interval, characteristics, contour maps and their use. Methods of contouring, contour gradient. Area and volume measurements from contour maps. (3 hours)

Curves: Introduction - simple curve - Basic definition - compound curve - reverse curve - transition curve – Bernoulli's lemniscate curve - vertical curve - design of vertical curve.

(11 hours)

Construction Surveying: Introduction - equipment's for setting out - pipe line - building and structures - staking out a highway. (2 hours)

Photogrammetric Surveying: Terrestrial - principles - photo theodolite, horizontal and vertical distances of points from photographic measurement. (2 hours)

Under Ground Surveys: Introduction - application of under-ground surveys - auxiliary theodolite-aligning the theodolite -problems in tunnel survey (3 hours)

Electronic Distance measurement: Introduction – Basic concept – Basic principles of EDM – Total Station Instruments – Computing distance from the Phase differences – Brief discription of EDM instruments. (3 hours)

TEXT / REFERENCES:

- David Clark, (1983), "Plane and Geodetic Surveying for Engineers", Vol I and II, - CBS Publication and Distributors, New Delhi.
- Norman Thomas, (1963), "Surveying", Edward Arnold Publishers (ELBS) London.
- Kanetkar T.P. and Kulkarni S.V., (1989), "Surveying and levelling", Part I and II, Pune Vidyarthi Griha Prakashana – Pune.
- Arora K.R., (1993), "Surveying", Vol. I and II, Standard Book House, New Delhi.
- Punmia B.C, (2005), "Surveying", Vol. I and II, Lakshmi Publications, New Delhi,

SURVEYING PRACTICE

ICE 235 0 - 0 - 3- 1

Leveling: Differential leveling, cross sectioning and reciprocal leveling, sensitiveness of bubble tube. Theodolite: Measurement of horizontal angles by repetition and reiteration methods. Trigonometrical leveling - single plane and double plane methods.

Tachometer: Determination of tacheometer constants. Measurement of distances and elevations.

Contouring: Direct and indirect method of contouring, radial and block leveling Curve surveying: Setting out simple curves by the method of deflection angles. Setting out compound curves by the method of deflection angles.

Setting out reverse curves when the straights meet at an acute angle and when the straight are parallel.
Total stations -Demo

TEXT / REFERENCES:

- Surveying and field work – Vol.1 & 2 by B.C. Punmia.
- Plane and geodetic surveying - Vol 1 by David Clark.
- Surveying and leveling - Vol 1 by T.P. Kanetkar and Kulkarni.
- Higher Surveying by Norman Thomas.
- Surveying by Higgins.

MATERIAL TESTING LABORATORY

ICE 236 **0 – 0 – 6 – 2**

Tension test on mild steel, compression test on cast iron, timber and shear test on mild steel and Rockwell hardness test, Brignell's hard ness test and bending test on wood, Impact tests.
Determination of specific gravity of fine and coarse aggregates, grading of coarse and aggregates, Bulking of sand, aggregate impact value (Los angles test).

Cement- Specific gravity, Fineness, consistency, setting times, soundness and strength.

Concrete- workability, Compressive strength

TEXT / REFERENCES:

- A.J.Fanner - Mechanical testing of materials – Georgenewnes Ltd - London
- 2. H.E. Davis, G.E.Troxell and C.T. Wiskocil - The testing and inspection of Engineering materials - McGraw Hill Book company
- K.H. Holes - Experimental Strength of materials - The English University Press Ltd., London .
- I.S. specification of cement, fine and coarse aggregates and concrete.
- Laboratory manual of concrete testing (Parts I & II) by V.V. Sastry & M.L. Gambhir.
- Properties of concrete by Neville.
- Shetty M.S., (2006), "Concrete Technology", S. Chand and Co.
- Neville and Brooks, (2003), "Concrete Technology", Pearson Education.
- Singh Gurucharan, (1988), "Materials of Construction", Std. Publishers.

IV SEMESTER

IHS 241 – ENGINEERING ECONOMICS & MANAGEMENT

(Refer page no.**45**)

HIGHWAY ENGINEERING

ICE 241 **3- 1 -0 –4**

Introduction: - Highway engineering, Scope of highway engineering, Highway classification, Factors controlling highway alignment, Engineering survey for highway location. (6 hours)

Traffic Engineering: - Traffic engineering, vehicular and road user characteristics, Traffic Studies-Speed, Density and Volume, Relation between speed, travel time and traffic volume, Traffic density and passenger car units, Traffic flow characteristics. (8 hours)

Geometric Design: - Elements of highway, factor and effecting friction, Camber, types of camber, width of formation, Sight distance-stopping and Overtaking, Horizontal curve, Extra widening, Super elevation, Transition curve, Vertical Curves-Summit and Valley Curves. (14 hours)

Pavements Design: - Types of pavements, Factors which influences design and selection of different types of pavements, Brief study on pavement materials, Design of Flexible and Rigid pavements- IRC method. (10 hours)

Highway Economics and Finance: -Methods of Economic Analysis- Motor vehicle operation cost, Highway finance. (6 hours)

Highway Drainage System: -Types of highway drainage and its design. (4 hours)

TEXT / REFERENCES:

- E.J. Yoder, Principles of Pavement Design, 2nd Edition, John Wiley & Sons, Inc. New York, 1975.
- Yang H. Huang, Pavement Analysis and Design, Prentice Hall, 2003.
- Khanna S.K and Justo C.E.G., (2001), "Highway Engineering", 8th Edition, Nemchand and Bros., Roorkee.
- Kadiyali L.R., (2000), "Traffic Engineering and Transportation Planning", 6th Edition, Khanna Publisher, New Delhi.

BUILDING DESIGN AND DRAWING

ICE 242 **0- 0 -3 –1**

Introduction to Auto cad: Introduction to Auto CAD for drafting Civil Engineering Drawings (2 hours)

Hand drawing of following Building Components/ Building to proportionate scale and drafted using Auto-Cad

Foundations: Plan, elevation and sectional views giving all details for different types of foundations – Masonry foundations, RCC Footings – Isolated, combined and raft footings.

Doors and Windows: Plan, elevation and sectional views giving all details for

a) Wooden and Aluminium doors, with
   i) Fully panelled
   ii) Fully glazed, (1 hour)
b) PVC doors and Steel doors
c) Collapsible Door, (2 hours)
d) Wooden windows with
   i) Partially glazed
   ii) Fully panelled.
e) Aluminium windows with
   i) Fully glazed Fixed and open able shutters
   ii) Fully glazed Sliding (2 leaves and 3 leaves) (2 hours)

Designing and Drawing of Residential Buildings: Plan, Elevation and Sectional views of Single bedroom house with Mangalore tiled roof, Double bedroom house with RCC roof. (2 hours)

Designing and Drawing of Public Buildings: Plan, Elevation and Sectional views of School Building, Bank, and Health Centre for the given Line Diagram. (4 hours)

Plan and elevation of single bed room RCC building with flat roof. (3 hours)

TEXT / REFERENCES:

- Balagopal Pabhu T.S., Vincent Paul K. and Vijayan C., (1999) "Building Design of Civil Engg. Drawing", Spades Publishers, Calicut.
- Shah and Kale, (1985), "Principle of Building Drawing", Tata McGraw Hill Publishing Co., New Delhi.
- Sharma and Kaul, (1976), "Text book of Building Construction", S. Chand, New Delhi.
- Rangawala S.C., "Elementary and advanced building Construction".
- IS National Building Code – 1970.Limited, [2009]
- IS National Building Code [1970]

WATER SUPPLY ENGINEERING

ICE 243 4- 0 -0 –4

Introduction: Need for protected water supply, essentials of water supply, project documents preparation. (2 hours)

Quantity of water - Population forecasting - different methods, rate of demand - factors affecting and its variation. (5 hours)

Sources of water: different sources of water, intakes/ water borne diseases and their control, conveyance of water (Pump capacity, Economical diameter). (4 hours)

Quality of water - Physical, chemical and biological characteristics, analysis of water, drinking water standards. (5 hours)

Treatment of water - Aeration of water - types of aerators, theory of sedimentation, sedimentation with coagulation, coagulants, feeding devices, mixing devices, flocculation - design considerations. (10 hours)

Filtration - types of filters - design considerations.
Disinfection – theory, methods of disinfections, chlorination.
Other treatment methods - softening of water, Removal of iron and manganese, defluoridation, desalination. (12 hours)

Distribution of water - distribution methods, systems of supply, service reservoirs and their capacity, layouts of distribution. (5 hours)

Pipe appurtenances: service connection, location of water supply pipes in buildings. wastage of water - Leakage detection & prevention, corrosion, and its prevention. (5 hours)

TEXT / REFERENCES:

- Manual on water supply and treatment CPHEEO, (1991), Ministry of Urban development, New Delhi.
- Garg S.K., (1999), "Environmental Engg. -I", Khanna Publishers, New Delhi.

- Birdie G.S., (1987), "Water Supply and Sanitary Engg.", Dhanpath Rai and Sons, New Delhi.
- B.C. Punmia, "Water Supply and Sanitary Engg.", Dhanpath Rai and Sons, New Delhi.
- Fair and Gayer, "Water Supply and Sanitary Engg.", Dhanpath Rai and Sons, New Delhi.

BASIC STRUCTURAL STEEL DESIGN

ICE 244 **3- 1-0 –4**

Introduction: scope and use of structural steel, Importance of steel construction. Corrosion, Fire protection and fatigue consideration in steel structures. (2 hours)

Limit state method of design: Allowable stress design, Limit state method of design, partial safety factors, and load combinations. (2 hours)

Structural fasteners: Bolted connections-type of bolts and bolted joints, specifications for bolts, strength of a joint, efficiency of joints, design of lap joints, butt joints and bracket connections. Welded connections – type of welds and welded joints, standard notations for fillet and Butt welds, strength of welds, design of lap joints, butt joints and bracket connections. (12 hours)

Design of Tension members: Types of sections used for tension members, effective length of compression members, classification of cross section, buckling class of cross sections, local and overall buckling, design of axially loaded tension member - plate, single angles, double angles and other sections with welded and bolted connections. (6 hours)

Compression member: Types of sections used for compression members, design of axially loaded compression member –standard sections, built up sections, laced and battened columns. Design of column splices, column bases – simple slab base and gusseted base for axially loaded column. (11 hours)

Design of flexural members: standard and built up sections. Design of beams –laterally supported and laterally unsupported compression flange. Web crippling, web buckling and deflection. (7 hours)

Welded Plate Girders : Elements of plate girder, proportioning of web, proportioning of flanges, self weight of plate girders, stiffeners - Detailed Design. (6 hours)

Design concepts for roof trusses (2hours)

TEXT / REFERENCES:

- Martin L.H and Purkiss J.A., "Structural Design of Steelworks to BS 5950", (1992), Edward Arnold, London.
- Subramanian N., "Design of Steel Structures", Oxford University press, New Delhi.
- Duggal S.K., "Limit State method of design of steel structures", (2010), Tata McGraw-Hill Bhavikatti S. S., (2010), "Design of Steel structures", I.K. International Publishing House, New Delhi.
- IS 800-2007: General construction in steel-Code of practice (third revision), Bureau of Indian Standards, New Delhi.

- IS 875-1987 (Part III): Code of practice for design loads (other than earthquake) for building structures, Bureau of Indian Standards, New Delhi.
- BS 5950 (part I) - 1985: Structural us of steelwork in buildings, British Standards Institution, London.
- SP: (6)-1964: Hand book for Structural Engineers, Bureau of Indian Standards, New Delhi.

ANALYSIS OF INDETERMINATE STRCUTURES

ICE 245 **3- 1 -0 –4**

Analysis of two hinged parabolic arches. Determination of horizontal reaction, normal thrust, radial shear and bending moment. Lateral yielding, rib shortening, and effect of temperature change. (4 hours)

Analysis of Simple Statically Indeterminate Beams: Analysis of propped cantilever, fixed and continuous beams by strain energy and consistent deformation methods. Analysis of continuous beams by three-moment theorem. (12 hours)

Analysis of statically indeterminate beams, bents and frames: using slope deflection, and moment distribution methods.

(12 hours)

Kani's method of Analysis: Analysis for continuous beams with and without support sinking. Analysis of symmetrical and non symmetrical frames with hinged and fixed boundary conditions. (6 hours)

Introduction to influence line diagrams for beams and analysis of beams by Muller's and Brauslo Principles (8 hours)

Plastic Analysis : Ductility, Behaviour in the plastic range, concept of plastic hinge, plastic moments, shape factor for different shapes of cross - section, redistribution of moment, collapse mechanism. Upper and lower bound theorems. Determination of collapse loads using static and kinematic methods for beams and frames structures. (6 hours)

TEXT / REFERENCES:

- Hibbeler, RC, Structural analysis, Pearson Education
- Daniel L Schodak, Structures, Pearson Education
- Reddy C.S., Basic structural Analysis, Tata McGraw Hill, New Delhi.(2004)
- Ramamrutham, Theory of Structures,
- Rao Prakash D.S., Structural Analysis, Universities Press, India. (1996)

FLUID MECHANICS LABORATORY

ICE 246 **0- 0 -6 –2**

Calibration of Triangular Notch, Rectangular Notch, Cippoletti Notch, Venturimeter, Orifices, Mouth pieces, Orifice meter, Broad crested weir, Curved weir, Ogee weir, Plug Sluice, Determination of Friction factor of pipes, Experiment on Venturi flume, Standing wave flume, Demonstration of Parshall Flume.

TEXT / REFERENCES:

- Streeter V.L and Wiley E.B., Fluid Mechanics, McGraw Hill Co. New York (1998)
- Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics Standard Book House, New Delhi.(2005)
- Jain A.K., Fluid Mechanics, Khanna Publishers, New Delhi (2002)
- Bansal R. K. Fluid Mechanics and Hydraulic Machines, Laxmi Publishers, New Delhi (2010)

V SEMESTER

PROJECT WORK

ICE 351 **0-0-36-12**

Students need to form batches with maximum four in numbers and required to identify the problem in their area of interest within their discipline of study under the supervision of a faculty (Guide) for 12 to 14 weeks. At the end, the findings need to be presented in the form of a project report for final evaluation.

VI SEMESTER

ADVANCED CONCRETE TECHNOLOGY

ICE 361 **3- 1 -0 -4**

Microstructure and Properties of Hardened Concrete: Importance of Bogue's compounds, Structure of a Hydrated Cement Paste, Volume of hydrated product, porosity of paste and concrete, transition Zone, Elastic Modulus, factors affecting strength and elasticity of concrete, Rheology of concrete in terms of Bingham's parameter. (9 hours)

Chemical admixtures: Mechanism of chemical admixture, Plasticizers and super Plasticizers and their effect on concrete property in fresh and hardened state, Marsh cone test for optimum dosage of super plasticizer, retarder, accelerator, Air-entraining admixtures, new generation superplasticiser. Mineral admixture-Fly ash, Silica fume, GCBS, and their effect on concrete property in fresh state and hardened state. (7 hours)

MIX Design: Factors affecting mix design, design of concrete mix by BIS method using IS 10262 (7 hours)

Durability of concrete: Introduction, Permeability of concrete, chemical attack, acid attack, efflorescence, Corrosion in concrete. Thermal conductivity, thermal diffusivity, specific heat. Alkali Aggregate Reaction, IS 456-2000 requirement for durability. (8 hours)

Special Types of Concrete: Fibre reinforced concrete - Fibres types and properties, Behaviour of FRC in compression, tension including pre-cracking stage and post-cracking stages, behaviour in flexure and shear. (6 hours)

Light weight concrete – materials, properties and types. Typical light weight concrete mix. (2 hours)

High volume fly ash concrete concept, properties, application. (2 hours)

Self-compacting concrete concept, materials, tests, properties, application. (2 hours)

High density concrete and high performance concrete-materials, properties and applications.

(2 hours)

RMC concrete - manufacture, transporting, placing, precautions, Methods of concreting-Pumping, under water concreting, shotcrete, (4 hours)

Non-destructive Methods: Rebound hammer, pulse velocity methods. (3 hours)

TEXT / REFERENCES:

- Monteiro and Mehta Concrete: Microstructure, Properties, and Materials, Fourth Edition. McGraw-Hill (2014).
- Gambhir, M.L. , Concrete Technology, Tata McGraw Hill, New Delhi
- Orchard, Concrete Technology, Applied Science Publishers Ltd. London
- Neville, Brooks, Concrete Technology, Addison – Wesley, England
- Neville A.M., Properties of Concrete, The English Language Book Society and India Publishing , London
- Raina V.K., Concrete for Construction , Tata-McGraw Hill Publishing Co. Ltd. New Delhi.
- Swamy, New Concrete Materials, Surrly University Press, London
- Shetty, M.S. Concrete Technology, M/S S. Chand & Co. Ltd. New Delhi

ESTIMATING AND COSTING

ICE 362 **3- 1 -0 -4**

Estimation : Definition, Types of estimate, Units of measurement, Method of estimation, project, contingencies, work charged establishment, plinth area, carpet area, Quantity calculation of different items for Residential buildings, R.C.C. works, roads, irrigation works etc.. Earth Work Calculation: Measurement of earth-work by cross-sections, spot levels, contours, mass diagram and its characteristics. (20 hours)

Specification: Definition, types, principles, Detailed specification for different components of buildings. (4 hours)

Rate Analysis: Purpose, factors affecting, overhead charges, Turn out of work, Rate analysis for different items of building. (6 hours)

Departmental Procedures: Functioning and organization of PWD, Tender and its notification, EMD and Security deposit, Qualification of contractor, responsibilities of engineer, owner, contractor. Different methods of execution of work, measurement book, nominal muster roll, running bill, agreement, schedule rate. Contract: Types of contract, termination of contract, work slip, Arbitration. (6 hours)

TEXT / REFERENCES:

- Dutta B.N., (2004), "Estimating and Costing in Civil Engineering Theory and Practice", Edition 25, UBS, Publishers, New Delhi.
- Chakraborti M., (2004), "Estimating Costing Specification and Valuation in Civil Engineering" Edition 17, Chakraborti Publishers, Kolkota.
- Gurucharan Singh, and Jagadish Singh, (2004), "Estimating Costing and Valuation", Edition 3, Standard Publisher Distributors, New Delhi.
- CPWD Manual for Standard Specification and Rate Analysis.
- PWD Karnataka Schedule of Rates.
- B.I.S. Code Book 1200 (Part 1 – 26) Method of Measurement of Building and Civil Engineering Works

ELECTIVE - I

ICE 363 **3-0-0-3**

PRESTRESSED CONCRETE DESIGN:

Basic Concepts of Prestressing: Need for high strength concrete and high tensile steel - Stress strain characteristics and properties. Advantages and applications of prestressed concrete. (2 hours)

Basic principles of prestressing: Load balancing concept, stress concept, centre of thrust. Pre-tensioning and Post-tensioning systems, tensioning methods and end anchorages. (4 hours)

Losses of prestress: Various losses in pretensioned and post tensioned systems, determination of jacking force. (4 hours)
Analysis of sections for flexure: Stresses in concrete due to pre-stress and loads, stresses in steel due to loads. (4 hours)
Camber and deflections: Prediction of short term and long term deflections of un cracked members; I.S. code provisions; Cable layouts. (4 hours)
Limit state of collapse and serviceability – Criteria for limit state, I.S. Code recommendations-Ultimate flexural and shear resistance of sections; shear reinforcement. Limit state of serviceability - Control of deflection and cracking. Classification of PSC structures. (8 hours)

Transmission of pre-stress in pre-tensioned members: transmission length, bond stress. Anchorage stresses in post tensioned members, bearing stress and bearing tensile force - stresses in end blocks - Methods, I.S. code provisions for the design of end block reinforcements. (6 hours)

Design of pre-tensioned and post-tensioned: symmetrical and unsymmetrical sections. Permissible stresses, design of pre-stressing force and eccentricity, limiting zone of pre-stressing force and eccentricity, cable profile. (6 hours)

TEXT / REFERENCES:

- Lin T.Y. and Ned. Burns H., "Design of Pre-Stressed Concrete Structures", John Wiley and Sons, New York.
- Krishna Raju N., "Pre-stressed Concrete", Tata McGraw Hill, New Delhi.
- Dayaratnam P., "Pre-stressed Concrete Structures", Oxford and IBH Publications, New Delhi.
- Mallick S. K. and Gupta A. P., "Pre-stressed Concrete", Oxford and IBH, New Delhi
- IS:1343-1980, Code of Practice For Prestressed concrete, Bureau of Indian Standards, New Delhi, 1981.

ADVANCED REINFORCED CONCRETE DESIGN:

Flat slabs: Introduction, Design using direct design method (with and without drops). (7 hours)
Retaining walls: Types of retaining walls, Design of Cantilever type and Counter fort type retaining wall. (7 hours)

Design of grid floors and portal frame: Single storey and single bay. Introduction to approximate method of design of multi - storey frames. (8 hours)

Water Tanks: Introduction, Design of water tanks as per IS 3370 code, Rectangular and circular tanks resting on ground, Overhead tanks - Intze type with supporting structures. (8 hours)

Silos and Bunkers: Introduction, Design of Silos and Bunkers. (6 hours)

Shells and Folded plates: Introduction, behavior of shells and folded plate roof forms. (2 hours)

TEXT / REFERENCES:

- Krishnaraju N., (2004), "Advanced Reinforced Concrete Design", CBI Publishers, New Delhi.
- Punmia B.C., (1992), "Reinforced Concrete Structures", 8th Edition, Lakshmi Publications Pvt. Ltd., New Delhi.
- Verghese P.C. (2005), "Advanced Reinforced Concrete" – Prentice HI New Delhi.
- Unnikrishna Pillai., Devadas Menon., (1998), "Reinforced concrete Design", Tata McGraw Hill Publishing Company Limited, New Delhi.
- IS:456 – 2000, "Code of practice for plain and Reinforced concrete", Bureau of Indian Standards, New Delhi
- SP-16 – 1984, "Design Aids for Reinforced concrete IS 456", Bureau of Indian Standards, New Delhi
- IS: 3370-Part II & Part IV, "Code of practice for Concrete Structures for The Storage of Liquids", Bureau of Indian Standards, New Delhi

ELECTIVE - II

ICE 364 **3-0-0-3**

WASTE WATER MANAGEMENT:

Introduction, Unit Operations, Unit Processes, Stabilization Ponds – Aerobic, Facultative & Anaerobic Lagoons, Septic tanks and their Design Aspects, Sludge Treatment, Sludge Digestion- Aerobic and Anaerobic, Energy recovery from digesters, Operation and Maintenance of treatment units, Disposal of wastes from various units.

TEXT / REFERENCES:

- George Tchobanoglous, Franklin Louis Burton, H. David Stensel, Wastewater Engineering - Treatment and ReuseMcGraw-Hill Education, (2003)
- Metcalf and Eddy,Wastewater Engineering: treatment disposal reuse, McGraw-Hill, (1979)
- S. C. Rangwala., Water Supply and Sanitary Engineering, Charotar Publishing House, (1990)
- S.K.Garg. Environmental Engineering Vol. I& II, Khanna Publishers, (2004)
- B C Punmia., Wastewater Engineering, Laxmi Publications, 2nd Edition, (1998)

AIR POLLUTION AND CONTROL:

Air pollution, Meteorology variables, primary and secondary pollutants, Effects of air pollution on - human health, animals, plants and materials, Industrial plant location and planning, Ambient and stack sampling, Air pollution control devices, Global effects of air pollution - Acid rain, Greenhouse effect, Ozone layer depletion, Air quality and emission standards, Air pollution index, Air pollution act.

TEXT / REFERENCES:

- Rao C.S., Environmental Pollution control, Wiley Eastern Ltd. Delhi, (1995)
- Rao H.V.N. and Rao M.N, Air pollution, Tata McGraw Hill, New Delhi, (1989)
- Air Pollution - Sampling and Analysis - APHA.

ELECTIVE – III

ICE 365 **2-1-0-3**

RAILWAY ENGINEERING AND AIRPORT:

RAILWAY ENGINEERING: Introduction: Role of railways in transportation, Indian Railways, Selection of Routes, Gauges and types, Typical cross sections-single and double line B G track in cutting, embankment and electrified tracks. (3 hours)
Tractive resistance: Resistant due to friction, wave action, curves, gradients, speed of the train; Hauling capacity and Tractive efforts. (3 hours)

Permanent way: Components parts rail and rail fastenings, ballast, sleepers, Railway creep, Anti-creep devices, coining of wheel, wear of rail. (3 hours)

Alignment Details: Grades and curves, effect of normal and ruling gradients, pusher and balance grades, super elevation, equilibrium cant, cant deficiency and grade compensation (3 hours)
Points and crossing: Necessity of turnouts, Switches and track junction, Design of turnout (3 hours)

Track Junctions: Introduction, Types of Track Junctions, Design calculation of simple junctions. (3 hours)
Missalenous Topics: Railway Station and Yards - Types of railway stations, classification of yards, Triangle, Turn Table, Scotch Block, Fouling marks, Buffer Stops. Signals - Classification, function, Control on movement of train by different methods. Interlocking - Types and function. (3 hours)

AIRPORT ENGINEERING:
Introduction: History and development of aviation, Aviation organizations and their functions, Aircraft characteristics and its influence on airport planning, Factors to be considered in Airport Planning, Site selection survey, Obstructions, Airport configuration. (4 hours)

Geometric Design: Runway orientation, Basic runway lengths, Geometric design of Runway Taxiways and Exit Taxiways. (5 hours)

Airport Capacity and Designing of Terminal Area: Runway and Terminal capacity and its improvement, Delay related capacity, Gate position and gate capacity, Planning and Designing of Terminal area , Aircraft parking system. (6 hours)

Visual aids and Air traffic control system: Flight rules, Navigational and landing aids, ILS (2 hours)

TEXT / REFERENCES:

- Horenjeff, R. and McKelvey, F. "Planning and Design of Airports", Fourth edition, Mc Graw Hill Company, New York, 1994.
- Ashford, N. and Wright, P.H., "Airport Engineering", Third edition, John Wiley and Sons, New York, 1992.
- Saxena S C and Arora S P "A Text Book Of Railway Engineering".
- Khanna S K., Arora M G and Jain S S "Airport Planning and Design".

PAVEMENT MATERIALS AND DESIGN:

Introduction: Types of pavements, Design wheel load – Maximum wheel load, Equivalent single wheel load, Soil classification, Strength determination of soil, Strength properties of mineral aggregates. (5 hours)

Design of Flexible pavement: Stress in Flexible pavements, Design factors, Design methods – IRC and AASHTO. (6 hours)

Bituminous Materials:- Introduction, Properties of Bitumen, Test on Bitumen and Bituminous materials, Binders, Engineering properties of Bituminous materials and Mix design. (4 hours)

Design of Rigid pavement: Westergaard's design factors, Critical load position and stress computation, Temperature stresses, Warping stresses, Bradburry equation for stress calculation, frictional stress, combination of stress , Design of slab thickness, position and types of joints, design of joints – design of tie bars and spacing of dowel bars. (8 hours)

Design of cement concrete mixes: Factor considered, BIS method of cement concrete mix design, IRC method, Dry Lean Cement concrete, Concrete mix design for rural roads. Roller compacted concrete. (3 hours)

Soil Stabilization Roads: Introduction, Mechanical Stabilization, Combining material to obtain required gradation, Soil-Lime stabilization, Lime-Cement-Soil stabilization, Soil-Cement stabilization, Soil Bitumen stabilization. (4 hours)

Design of Runway Pavement: Requirements, Types of pavements, Design of Flexible pavement, Design of Rigid pavement. (4 hours)

Pavement Failure and Evaluation: Types of failure in flexible and rigid pavements, causes of failure and precautionary measures, Structural evaluation of Flexible pavement- Benkelman Beam Deflection Method, Falling weight deflectometer, GPR Method, Structural evaluation of Rigid pavement- Functional Evaluation by visual inspection and unevenness measurements. (4 hours)

TEXT / REFERENCES:

- E.J. Yoder, Principles of Pavement Design, 2nd Edition, John Wiley & Sons, Inc. New York, 1975.
- Yang H. Huang, Pavement Analysis and Design, Prentice Hall, 2003.
- Khanna S.K and Justo C.E.G., (2001), "Highway Engineering", 8th Edition, Nemchand and Bros., Roorkee.
- Dr Kadiyali L.R and Dr Lal N.B (2003), "Prinicples and Practices of Highway Engineering", 4th Edition, Khanna Publisher, New Delhi.

ELECTIVE – IV

ICE 366 **3-0-0-3**

GROUND IMPROVEMENT TECHNIQUE:

Introduction: Ground Improvement: Definition, Objectives of soil improvement, Classification of ground improvement techniques, Factors to be considered in the selection of the best soil improvement technique. Principle of modification for various types of soils. (3 hours)

Mechanical Modification: Type of mechanical modification, Aim of modification, Methods of compaction-shallow and deep compaction, Properties of compacted soil, Compaction control tests, Field compaction – static, dynamic, impact and vibratory type. Vibro compaction and vibro replacement-stone columns. Effect of compaction on engineering behaviour of soil, Specification of compaction. (7 hours)

Hydraulic Modification: Definition, aim, principle, techniques. gravity drain, lowering of water table, multistage well point, vacuum dewatering, Electro kinetic dewatering. Preloading-Methods Vertical drains-Sand drains and prefabricated drains. (7 hours)

Chemical Modification : Definition, Techniques – sandwich technique, Modification by admixtures- granular admixtures, cement, lime, flyash, industrial wastes etc., Stabilization of soil with lime columns and cement columns. Stabilization using other chemicals - chlorides, hydroxides, lignin, hydrofluoric acid, Bitumen, tar or asphalt. Modification at depth by grouting-techniques, grouting plant, applications of grouting, materials used for grouting. (8 hours)

Miscellaneous methods: Thermal Modification, Soil reinforcement. Anchors, Rock bolts and soil nailing. Ground improvement by confinement – Crib walls, Gabions and Mattresses. Geosynthetics - Types, Civil Engineering applications of geo-synthetics. (11 hours)

TEXT / REFERENCES:

- Fang H.Y., (1997), "Foundation Engineering Hand book", 2nd edition, CBS publishers and Distributors, New Delhi.
- Alam Singh and Chowdhary G.R., (1990), "Soil Engineering in Theory and Practice" Part-3, CBS Publishers and Distributors, New Delhi.
- Alam Singh, (1988), "International Overviews Current Practices in Geotechnical Engineering", IBT Publishers and Distributors, New Delhi.
- Kuberan R., Nakul Dev and Govindan K.K., "Geotechnical Engineering", Indian Experiences, A Compilation of IGS Annual Lectures, 1978 - 1992, Edition Indian Geotechnical Society.
- M.R. Hausmann (1990), "Engineering Principles of Ground Modifications", McGraw Hill Publishing Co.
- Purushotham Raj, "Ground Improvement Techniques", Laxmi Publications, New Delhi.

APPLIED SOIL ENGINEERING:

Soil Exploration: Objectives of exploration, planning of exploration program, soil samples and soil samplers, field penetration tests: SPT, SCPT, DCPT. Introduction to geophysical methods, Ground water investigations, Bore log and report writing. (8 hours)

Earth pressure: Earth pressure at rest, active and passive conditions, Rankine's theory (no derivation) for active and passive condition for cohesion less and cohesive soil. (7hours)

Stability of slopes - Finite and infinite slopes, Types of failure of Finite slopes. Factor of safety, Stability of finite slopes by Method of slices and Swedish Circle method, Friction circle method, Factor of safety using Taylor's stability chart. (7 hours)

Bearing capacity of shallow foundations –Types of shallow foundation, Modes of shear failure, factors affecting bearing capacity, allowable bearing pressure, determination of bearing capacity-as per IS code, Permissible, total and differential settlement , Estimation of bearing capacity from plate load and penetration tests. (7 hours)

Pile foundations: Introduction, types of piles according to their composition, their method of installation and their load carrying characteristics, piles subjected to vertical loads- pile load carrying capacity from static formula, dynamic formulae (ENR and Hiley), penetration test data & Pile load test. Pile group: carrying capacity, efficiency and settlement. Negative skin friction. Under-reamed piles and Bored compaction piles. (7 hours)

TEXT / REFERENCES:

- Bowels J.E. (1998), "Foundation Analysis and Design", McGraw-Hills Book Company 4th Edition.
- Shashi K Gulati and Manoj Datta, (2005), "Geotechnical Engineering", Tata McGraw-Hill Publishing company limited, New Delhi.
- Hsai – Yang Fang, (2001), "Foundation Engg.", Hand Book, CBS
- Publishers and Distributors, 2nd Edition, New Delhi.
- Arora K.R., (2008), "Soil Mechanics and Foundation Engineering", Standard, Publishers and Distributors, 7th Edition.
- Gopal Ranjan and Rao A.S.R., (2000), "Basic and Applied Soil Mechanics", New Age International (P) Limited, Publishers, 2nd Edition.
- Punmia B.C., (2005), "Soil Mechanics and Foundations", Laxmi Publications Pvt., Ltd., 16th Edition.
- Venkataramaiah C (2006), "Geotechnical Engineering", New Age International Limited, Publishers, New Delhi.

SEMINAR

ICE 367 **0-0-3-1**

Students need to present a seminar on a topic of recent developments in their subject filed.

ENVIRONMENTAL ENGINEERING LABORATORY

ICE 368 **0-0-3-1**

Determination of solids, Turbidity determination and Jar test, Determination of Alkalinity, Acidity and Ph, Calcium, Magnesium and total Hardness, Chlorides, dissolved oxygen and BOD determination, Residual chlorine and chlorine demand, Determination of Iron and Fluorides, Determination of C.O.D., Ammoniacal Nitrogen and Nitrates, Demonstration of High volume sampler and sound level meter, determination of oil, grease and Sulphates.

TEXT / REFERENCES:

- Standard Methods for the Examination of Water and Waste Water – ALPHA – AWWA – WPCF
- Sawyer and Mc Carty, Chemistry for Environmental Engineering, McGraw Hill, New York. (1994)
- IS – 3025 – 1964 – Methods of Sampling and Test (Physical and Chemical) for Water Used in Industry, IIT New Delhi.
- Drinking water Standards IS – 10500-2004.

COMPUTER APPLICATIONS LABORATORY

ICE 369 **0-0-3-1**

Introduction to STAAD software package. Analysis of continuous beams using STAAD, Analysis of plane trusses, plane frames, and space frames using STAAD, Design of frames using STAAD package, Introduction and application of ETABS

TEXT / REFERENCES:

- STAAD Pro software tutorial.
- ETABS software tutorial.

B.Sc. (COMPUTER SCIENCE)

II SEMESTER

IMA 121 – MATHEMATICS - II (Refer page no.**33**)
IPH 121 – PHYSICS - II (Refer page no.**33**)
ICH 121 - CHEMISTRY (Refer page no.**35**)

JAVA PROGRAMMING

ICS 121 **3-1-3-5**

INTRODUCTION: The Java Language, The Key Attributes of Object Oriented Programming, The Java Development Kit, A First Simple Program, Programming Basics, The Java Keywords, Identifiers in Java, The Java Class Libraries. (2 hours)

LANGUAGE BASICS:Java's Primitive Types, Literals, Variables, Scope and Lifetime of Variables, Operators and Operator Precedence, Expressions, Input, Control Structures, Arrays and Strings. (4 hours)

INRODUCTION TO CLASSES, OBJECTS AND METHODS: Class Fundamentals, Creating Objects, Reference Variables and Assignment, Methods, Returning from a method, Returning a Value, Using Parameters, Constructors, Parameterized Constructors, The new operator, Garbage Collection and Finalizers, this keyword, Controlling Access to Class Members, Pass Objects to Methods, Arguments Passing, Returning Objects, Method Overloading, Overloading Constructors, Understanding static, Nested and Inner Classes, Variable Length Arguments. (8 hours)

INHERITANCE: Inheritance Basics, Member Access and Inheritance, Constructors and Inheritance, User Super to Call Superclass Constructors and Access Superclass Members, Creating Multilevel Hierarchy, Order of execution of Constructors, Superclass References and Subclass Objects, Method Overriding and Polymorphism, Using Abstract Classes, Using Final, The Object Class. (6 hours)

INTERFACES: Interface Fundamentals, Creating and Interface, Implementing an Interface, Using Interface References, Implementing Multiple Interfaces, Constants in Interfaces, Extending Interfaces, Nested Interfaces. (4 hours)

PACKAGES: Package Fundamentals Packages and Member Access, Importing Packages, Static Import (3 hours)

EXCEPTION HANDLING: Exception Hierarchy, Exception Handling Fundaments, Consequences of an Uncaught Exception, Handling Errors through Exceptions, Using Multiple catch Clauses, Nesting try blocks, Throwing an Exception, Closer look at Throwable, Using finally, Using throws, Built-in Exceptions, Creating Exception Subclasses. (4 hours)

MULTITHREADED PROGRAMMING: Multithreading Fundamentals, The Thread Class and Runnable Interface, Creating a Thread and Multiple Threads, Determining when a Thread Ends, Thread Priorities, Synchronization, Using Synchronized Methods, The synchronized statement, Thread Communication, Suspending, Resuming and Stopping Threads. (6 hours)

USING INPUT OUTPUT: Char and Byte stream classes, Predefined streams, Console i/o using streams, Reading and Writing Files using Bytestreams and Charstreams. File, Filename Filter, Random Access File class. (4 hours)

SWINGS AND EVENT HANDLING: The origins and design philosophy of swings, components and containers, Layout Managers, Event handling, using pushbutton, JTextField, Anonymous inner classes to handle events. (7 hours)

JAVA PROGRAMMING LABORATORY

Implementing programs in Java using Control statements and arrays, Classes and methods, Inheritance and Packages, Interfaces, Exception Handling, Threads , Input/Output , Applets and Event Handling , Generics, String handling, Swings

TEXT/ REFERENCES:

- Herbert Schildt and Dale Skrien, "Java Fundamentals – A Comprehensive Introduction", McGrawHill, First Edition, 2013.
- Herbert Schildt, "The Complete Reference JAVA 2", Tata McGrawHill, 8th Edition 2011.
- Dietel and Dietel, "Java How to Program", 9th Edition, Prentice Hall India, 2012.
- Steven Holzner, "Java 2 programming BlackBook",DreamTech,India 2005.

COMPUTER ORGANIZATION AND ARCHITECTURE

ICS 122 3-1-0-4

BASIC STRUCTURE OF COMPUTERS: Computer types, Functional units, Basic operational concepts, Number Representation and Arithmetic Operations, Character Representation, Performance, Problems (3 hours)

INSTRUCTION SET ARCHITECTURE: Memory locations and addresses, Memory operations, Instructions and Instruction Sequencing, Addressing modes, CISC Instruction Sets, RISC and CISC Styles, Example Programs. (3 hours)
ARITHMETIC AND LOGIC UNIT: Number Systems-Positional number systems-Decimal, Binary, Hexadecimal, Conversions, The ALU-Integer and Floating point arithmetic. (9 hours)

PROCESSING UNIT:CPU structure and Function: processor organization, register organization, Instruction cycle, Control Unit Operation: Micro operations, Control of the processor(exclude Intel 8085), hardwired Implementation, micro-programmed control-Basic concepts, micro instructions, micro programmed control unit, wilkes control, microinstruction sequencing – Design considerations, sequencing techniques, Address generation, Microinstruction execution – a taxonomy of micro instructions, microinstruction encoding. (7 hours)
MEMORY SYSTEMS: Basic concepts, RAM memories, Read only memories, Memory Hierarchy, Cache memories-mapping functions, Placement strategies, Replacement algorithms, Performance considerations, Virtual memories, Secondary storage. (10 hours)

INPUT/OUTPUT ORGANIZATION: Accessing I/O devices, I/O Device Interface, Program-Controlled I/O, An Example of a RISC-Style I/O Program, An Example of a CISC-Style I/O Program, Interrupts, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling I/O Device Behavior, Processor Control Registers, Direct Memory Access, Bus Structure, Bus Operation, Synchronous Bus, Asynchronous Bus, Interface circuits- Parallel Interface, Serial Interface (8 hours)

INTRODUCTION TO PARALLEL ARCHITECTURE: ipelining- Basic Concept, Pipeline Organization, Pipelining Issues, Data Dependencies, Operand Forwarding, Handling Data Dependencies in Software, Memory Delays, Branch Delays, Unconditional Branches, Conditional Branches, The Branch Delay Slot, Branch Prediction, Hardware Multithreading, Vector (SIMD) Processing, Graphics Processing Units (GPUs), Shared-Memory Multiprocessors, Interconnection Networks, Cache Coherence, Write-Through Protocol, Write-Back protocol, Snoopy Caches, Directory-Based Cache Coherence . (8 hours)

TEXT/ REFERENCES:

- Carl Hamacher, ZvonkoVranesic and SafwatZaky, "Computer Organization and Embedded Systems", Sixth edition, McGraw Hill Publication, 2012.
- William Stallings, "Computer Organization and Architecture Designing for Performance", Tenth edition, Pearson Education Limited , 2016
- D.A. Patterson and J.L.Hennessy, "Computer Organization and Design-The Hardware/Software Interface", Fifth Edition, Morgan Kaufmann, 2011.

III SEMESTER

IMA 231 – MATHEMATICS - III (Refer page no.**39**)
IEC 231 – ANALOG ELECTRONIC CIRCUITS (Refer page no.**63**)

DATA STRUCTURES

ICS 231 **3– 1– 3 – 5**

Algorithm Analysis: Space Complexity, Time Complexity, Big-oh notation (2 hours)

Recursion: Definition & Examples, Complexity analysis of Recursive algorithms (3 hours)

Stacks: Definitions & implementation, Representation, Operations on Stacks, Applications of Stacks, (6 hours)

Queues: Definition, Representation, Operations on Queues, Priority Queues (3 hours)

Linked lists: Singly Linked lists, Doubly Linked lists (4 hours)

Trees: Definition, Representation, Binary Trees – Operations, Recursive and Iterative Traversal. Binary Search Trees, Height Balanced Trees - AVL Trees (12 hours)

Searching: Linear Search, Binary Search, Comparative Performance of Searching Algorithms (3 hours)

Hashing: Abstract Data Type, Static Hashing - Hash Tables, Hashing Functions, Overflow Handling (3 hours)

Sorting: Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Time Complexity Analysis of the above Sorting Methods. (6 hours)

Graphs: Types of Graphs, Representation - Adjacency Matrix, Adjacency Lists, Traversals-Depth-First Search and Breadth-First Search (6 hours)

DATA STRUCTURES LABORATORY

Recursive programs, Implementation of Stacks and queues using arrays, Linked lists, Implementation of stack and queue using linked list, Binary trees – traversal, insertion, deletion, Binary Search trees, Linear Search, Binary Search, Sorting Programs.

TEXT / REFERENCES:

- Ellis Horowitz, Sartaj Sahni, Dinesh P. Mehta "Fundamentals of Data Structures in C ++" , Universities Press, 2nd Edition, 2008.
- Narasimha Karumanchi, "Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles", (5e),Careermonk Publications, 2016
- Tenenbaum Aaron M., LangsamYedidyah, Augenstein Moshe J., "Data Structures using C and C++", (2e), Prentice Hall of India Ltd., 2012.
- Mark Allen Weiss, "Algorithms, Data Structures and Problem solving with C++",(3e), Addison Wesley , 2006

SWITCHING CIRCUITS AND LOGIC DESIGN

ICS 232 **3– 1– 3 – 5**

INTRODUCTION TO LOGIC CIRCUITS: Variables and functions, Inversion, Truth Tables: AND OR, NOT, NAND, NOR, XOR gates, Logic Gates and Networks, Boolean algebra, Synthesis using AND, OR and NOT gates, NAND and NOR logic Networks, Introduction to Verilog HDL (8 hours)

OPTIMIZED IMPLEMENTATION OF LOGIC FUNCTIONS: Karnaugh Map, Strategy for minimization, Minimization of POS forms, Incompletely Specified Functions, Multiple Output Circuits, Multilevel Synthesis, Multilevel NAND and NOR Circuits, Quine-McCluskey method simplification (9 hours)

ARITHMETIC CIRCUITS:Positional Number Representation, Addition of unsigned numbers, Signed numbers, Arithmetic Circuits: Half Adder, Full Adder, Ripple Carry Adder, Adder/Subtractor, Fast adders-Carry Look Ahead adder, BCD Adder, Design of Arithmetic Circuits Using Verilog (7 hours)

COMBINATIONAL CIRCUIT BUILDING BLOCKS: Multiplexer, Decoder, Encoder, Code converter, Arithmetic comparison circuits, Verilog for Combinational Circuits. (7 hours)

SYNCHRONOUS SEQUENTIAL CIRCUITS: Flip-Flops, Analysis and Design of Synchronous Sequential Circuits, Ripple Counters, Registers, Shift Registers, Ring and Johnson Counters, Using Verilog Constructs for Storage Elements. (12 hours)

SWITCHING CIRCUITS: Transistor Switches, NMOS, CMOS Logic Gates, Programmable Logic Devices, Noise Margin, Power dissipation, Transmission Gates, Fan-in, Fan-out, Tristate drivers (5 hours)

SWITCHING CIRCUITS & LOGIC DESIGN LABORATORY

Introduction to Logic gates, Implementation of Boolean functions using gates , Code converter circuits, Magnitude comparators, Arithmetic circuits, Multiplexers Demultiplexers/Decoders ,Encoders, Flip Flops and ripple counters, Synchronous counters , Combinational and sequential

circuits. Implimentation of ALU/Control Signals of RISC processors. Implementation of the above using Verilog HDL

TEXT / REFERENCES:

- Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design" Tata McGraw Hill Publishing Co. Ltd., 3rd Edition, 2014.
- M. Morris Mano, "Digital Design", PHI Pvt. Ltd., 2nd Edition, 2000.
- Donald D. Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Co. Ltd, 2003
- John F. Wakerly, "Digital design - Principles and practice", Pearson Education, 4th Edition, 2013.

SOFTWARE DESIGN USING OBJECT ORIENTED PARADIGM

ICS 233 3– 0– 6 – 5

UML DIAGRAMS: Introduction to OOAD – Unified Process - UML diagrams – Use Case – Class Diagrams– Interaction diagrams – State Diagrams – Activity Diagrams – Package, component and Deployment Diagrams. (8 hours)

CASE STUDY : Case study – the Next Gen POS system, Inception -Use case Modeling - Relating Use cases – include, extend and generalization - Elaboration - Domain Models - Finding conceptual classes and description classes – Associations –Attributes – Domain model refinement – Finding conceptual class Hierarchies - Aggregation and Composition. (8 hours)

APPLYING DESIGN PATTERNS: System sequence diagrams - Relationship between sequence diagrams and use cases- Logical architecture and UML package diagram – Logical architecture refinement - UML class diagrams – UML interaction diagrams – Applying GoF design patterns. (8 hours)

DESIGN PATTERNS:
GRASP: Designing objects with responsibilities – Creator – Information expert – Low Coupling – High Cohesion – Controller - Design Patterns – creational - factory method - structural – Bridge – Adapter - behavioral – Strategy –observer. (6 hours)

CODING AND TESTING: Mapping design to code – Testing: Issues in OO Testing – Class Testing – OO Integration Testing –GUI Testing – OO System Testing. (6 hours)

SOFTWARE DESIGN USING OBJECT ORIENTED PARADIGM LABORATORY

Requirement elicitation for a given problem, Create use case diagram, activity diagram, sequence diagram, collaboration diagram, Domain class and detailed class diagram of the given system, Create a state chart diagram for each of the classes identified, Miniproject

TEXT / REFERENCES:

- Craig Larman, "Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development", Third Edition, Pearson Education, 2005. Reprint 2015
- Simon Bennett, Steve Mc Robb and Ray Farmer, "Object Oriented Systems Analysis and Design Using UML", Fourth Edition, Mc-Graw Hill Education, 2010.
- Erich Gamma, a n d Richard Helm, Ralph Johnson, John Vlissides, "Design patterns: Elements of Reusable Object-Oriented Software", Addison-Wesley, 1995.
- Martin Fowler, "UML Distilled: A Brief Guide to the Standard Object Modeling Language", Third edition, AddisonWesley, 2003.
- Paul C. Jorgensen, "Software Testing:- A Craftsman's Approach", Third Edition, Auerbach Publications, Taylor and Francis Group, 2008.

IV SEMESTER

IHS 241 – ENGINEERING ECONOMICS & MANAGEMENT

(Refer page no.**45**)

IEE 241 - SIGNALS AND SIGNAL PROCESSING

(Refer page no.**68**)

MICROPROCESSORS

ICS 241 **3- 0 -6 –5**

8086 FAMILY ASSEMBLY LANGUAGE PROGRAMMING: 8086 internal architecture, Introduction to programming the 8086, Addressing modes, assembler and Assembler directives, Simple sequence programs, Jumps, Flags, and conditional jumps, Loop instructions, Instruction timing and delay loops. (8 hours)

STRINGS, PROCEDURES, AND MACROS: The 8086 String instructions, Writing and Using Procedures and Macros. (4 hours)

8086 INTERRUPTS AND INTERRUPT APPLICATIONS: 8086 Interrupts and Interrupt Responses, 8259 Priority Interrupt Controller, 8255- Programmable Parallel ports and Handshake Input/ Output. (5 hours)

8086 SYSTEM CONNECTIONS TIMING: Min and Max mode operation, Reset and Wait state, Min and max mode input, output timing diagrams. (3 hours)

THE 80286, 80386, and 80486 PROCESSORS : 80286 Architecture: enhancement features-Protected mode addressing, Selectors and descriptors, Introduction to 80386 architecture-enhanced features, The Memory System, The Input/Output System, Memory and I/0 Control Signals, Special 80386 Registers, 80386 Memory Management, Protected Mode, Virtual Mode, The Memory Paging Mechanism, Introduction to The 80486 Microprocessor, Basic 80486 Architecture, 80486 Memory System. (8 hours)

THE PENTIUM AND PENTIUM PRO MICROPROCESSORS : Introduction to the Pentium Microprocessor, The Memory System, Input/Output System, Branch Prediction Logic, Cache Structure, Superscalar Architecture, Special Pentium Registers, Pentium Memory Management,

Introduction to The Pentium Pro Microprocessor, Internal Structure of the Pentium Pro, The Memory System, Input/Output System, Special Pentium Pro Features (4 hours)

THE PENTIUM II, PENTIUM III, PENTIUM 4 AND CORE2 MICROPROCESSORS : Introduction to the Pentium II Microprocessor, The Memory System, Input/Output System, Pentium II Software Changes, Introduction The Pentium III, Chip sets, Bus, The Pentium 4 and Core2, Memory Interface, Register Set. (4 hours)

MICROPROCESSOR LABORATORY

Basics of Assembly Programming, Simple Programs using Addition, Subtraction and Branching Instructions, Operations on BCD and ASCII data (Packing, Unpacking, Conversion between BCD and ASCII), Multiplication and Division, List Operations (Arrays), String Operations, DOS and BIOS interrupts – String Operations, DOS interrupts – Integer Operations and file operations, Logic Controller Interfacing, DAC Interfacing, Keyboard Interfacing, Seven Segment Display Interfacing, Stepper Motor, ADC Interfacing, Elevator Interfacing

TEXT / REFERENCES:

- Douglas V. Hall, "Microprocessors and Interfacing", Tata McGraw Hill Publications Ltd., Revised Third Edition, 2008.
- Barry B. Brey, "The Intel Microprocessors Architecture, Programming, And Interfacing" Prentice Hall India, 8th Edition, 2009.
- Nilesh B Bahadure, "Microprocessors The 8086/8088, 80186/80286, 80386/80486 and the Pentium Family", Prentice Hall India, 2010
- Kenneth Ayala, "The 8086 Microprocessor: Programming & Interfacing the PC", Ceneage learning India Pvt. Ltd., 2007.

DATABASE MANAGEMENT SYSTEMS

ICS 242 **2- 1 -3 –4**

Introduction: Database-System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Database Design, Data Storage and Querying, Transaction Management, Database Architecture, Database Users and Administrators. (3 hours)

Relational Model: Structure of Relational Databases, Database Schemas, Keys, Relational Query Languages, Relational Operations. (4 hours)

SQL: SQL Data Definition, SQL Data Types and Schemas, Integrity Constraints, Basic Structure of SQL Queries, Set Operations, Aggregate Functions, Nested Subqueries, Additional Basic Operations Null Values, Modification of the Database. Join Expressions, Views, Transactions, Introduction to PL/SQL. (8 hours)

Database Design Using E-R Model: Overview of the Design Process, The Entity-Relationship Model, Constraints, Removing Redundant Attributes in Entity Sets, Entity- Relationship Diagrams, Entity-Relationship Design Issues, Extended E-R Features, Reduction to Relational Schemas. (3 hours)

Normalization :Features of Good Relational Design, Atomic Domains and First Normal Form, Decomposition Using Functional Dependencies, Functional Dependency Theory, Algorithms for Decomposition ,Decomposition Using Multivalued Dependencies. (7 hours)

Indexing and Hashing : File Organization, Organization of Records in Files, Basic concepts, Ordered Indices, B+ Tree Index Files, B+ Tree Extensions, Multiple-Key Access, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing. (6 hours)

Transaction Management :Transaction Concept, A simple Transaction model, Transaction Atomicity and Durability, Transaaction Isolation , Serializability, Transaction Isolation and Atomicity, Transaction Isolation Levels, Recovery and Atomicity, Recovery algorithm. (5 hours)

DATABASE MANAGEMENT SYSTEMS LABORATORY

Implementation of ER diagrams using DIA tool, Designing the different databases and working with queries using SQL. Working with Advanced SQL like, Exceptions Cursors, Procedures, Functions and Packages, Mini-Project work using Java as front end and Oracle/PostgresSQL as back end

TEXT / REFERENCES:

- Silberschatz, Korth, Sudarshan, "Database System Concepts", 6th Edition, McGrawHill,New York, 2011.
- Ivan Bayross, "SQL, PL/SQL", 4th Edition, BPB Publications, USA, 2009.
- Ramez Elmasri and Shamkant Navathe, Durvasula V L N Somayajulu, Shyam K Gupta, "Fundamentals of Database Systems", 6th Edition, Pearson Education, United States of America, 2011.
- Thomas Connolly, Carolyn Begg, "Database Systems – A Practical Approach to Design, Implementation and Management", 4th Edition, Pearson Education,England, 2005.
- Carlos Coronel and Steven Morris, "Database Systems–Design, Implementation and Management", (12e), Course Technology, 2016.
- Peter Rob, Carlos Coronel, "Database Systems–Design, Implementation and Management", 10th Edition, Course Technology, Boston , 2013.

OPERATING SYSTEMS

ICS 243 **2- 1 -0 –3**

Introduction: What Operating Systems Do, Operating System Structure , Operating System Operations, Process Management, Memory Management, Storage Management, Protection and Security. (2 hours)
System structure :Operating System Services, User Operating System Interfaces, System Calls, Types of System Calls, System Programs, Operating System Structure. (2 hours)
Process concept: Overview, Process Scheduling, Operations on Processes, Interprocess Communication. (2 hours)
Multithreaded programming: Overview, Multithreaded Models, Thread Libraries, Threading Issues. (3 hours)
Process scheduling : Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Linux scheduling. (4 hours)
Synchronization: Background, Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Problems of Synchronization. (4 hours)
Deadlocks: System Model, Deadlock, Characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock Avoidance. (4 hours)

Memory management strategies: Logical Versus Physical Address Space, Swapping, Contiguous Memory Allocation, Paging, Page Table Structure, Segmentation. (4 hours)
Virtual memory management: Background, Demand Paging, Copy-On-Write, Page Replacement, Allocation of Frames, Thrashing. (5 hours)

File system : File Concept, Access Methods, Directory Structure, File Sharing. (2 hours)

Protection : Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix Implementation of Access Matrix. (2 hours)
Linux system : Linux system design Principles, Kernel Modules. (2 hours)

TEXT / REFERENCES:

- Silberschatz, P. B. Galvin and G. Gagne, "Operating System Concepts", Ninth Edition, Wiley and Sons (Asia) Pt. Ltd. 2012.
- H. M. Dietel, "An Introduction to Operating Systems", Addison Wesley, second edition, 2002.
- Andrew S. Tannebaum, "Operating System: Design and Implementation", Prentice Hall of India, 3rd edition 2008.
- Maurice J Bach, "Design of Unix Operating System", Pearson Education, 2015.

DESIGN & ANALYSIS OF ALGORITHMS

ICS 244 **2- 1 -0 –3**

Introduction: Introduction, Fundamentals of Algorithmic Problem Solving, Important Problem Types, Fundamental Data Structures. (3 hours)
Fundamentals of the analysis of algorithm efficiency :Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Nonrecursive and Recursive Algorithms, Example. (4 hours)
Brute force : Selection Sort and Bubble Sort, Sequential Search and Brute-Force String Matching, Exhaustive Search Method, Depth First Search, Breadth First Search. (5 hours)
Decrease and conquer : Insertion Sort, Topological Sorting, Algorithms for generating Combinatorial Objects. (3 hours)
Divide and conquer : Mergesort, Quicksort, Binary Search, Multiplication of large integers and Strassen's Matrix Multiplication. (4 hours)
Transform and conquer: Presorting, Balanced Search Trees, Heaps and Heapsort, Problem Reduction (4 hours)
Space and time tradeoffs :Sorting by Counting, Input Enhancement in String Matching, Hashing. (4 hours)
Dynamic programming: Basic Examples, The Knapsack Problem and Memory Functions, Warshall's and Floyd's Algorithms (5 hours)
Greedy technique :Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees. (4 hours)

TEXT / REFERENCES:

- Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, India, 2011.
- Ellis Horowitz and Sartaj Sahni, "Computer Algorithms/C++", 2nd Edition, University Press, India, 2007.
- Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, "Introduction to Algorithms", 2nd Edition, PHI, India, 2006.

V SEMESTER

PROJECT WORK

ICS 351 **0-0-36-12**

Students need to form batches with maximum four in numbers and required to identify the problem in their area of interest within their discipline of study under the supervision of a faculty (Guide) for 12 to 14 weeks. At the end, the findings need to be presented in the form of a project report for final evaluation.

VI SEMESTER

COMPUTER COMMUNICATION AND NETWORKS

ICS 361 **3-1-0-4**

INTRODUCTION:Overview of the Internet- Networks, Switching,The Internet, Accessing the Internet, Hardware and Software, Protocol Layering – Scenarios, TCP/IP Protocol Suite, The OSI Model, Internet History. (3 hours)

DATA TRANSMISSION: Concepts and Terminology, Analog and Digital Data Transmission, Transmission Impairments, Channel Capacity, Decibels and Signal Strength. (8 hours)

GUIDED AND WIRELESS TRANSMISSION: Guided Transmission Media, Wireless Transmission. (3 hours)
SIGNAL ENCODING TECHNIQUES:Digital Data, Digital Signals, Digital Data, Analog Signals. (6 hours)
DATA LINK LAYER: Nodes and Links, Two Types of Links, Two Sub layers, Data Link Control- Framing, Flow and Error Control, Error Detection and Correction, Two DLC protocols, Multiple Access Protocols- Random Access, Controlled Access, Channelization, Link Layer Addressing, Wired LANS Ethernet Protocols- IEEE Project 802, Standard Ethenet. (8 hours)
DATA LINK CONTROL:Flow Control, Error Control, Performance Issues. (6 hours)

WIRELESS NETWORKS AND MOBILE IP:Introduction, IEEE 802.11 Project, Mobile IP-Addressing, Agents, 3 Phases, Inefficiency in Mobile IP. (4 hours)

NETWORK LAYER: Network Layer Services, Packet Switching, Network Layer Performance, Network Layer Congestion, Structure of a Router, Network Layer Protocols- IPv4 Datagram Format, IPv4 Addresses, Forwarding of IP Packets, ICMPv4, Unicast Routing- General Idea, Routing Algorithms, Unicast Routing Protocols, Multicast Routing- Introduction, Multicasting Basics, Intradomain, Interdomain Routing Protocols, Next Generation IP- IPv6, Addressing, Transition from IPv4 to IPv6, ICMPV6. (10 hours)

TEXT / REFERENCES:

- Behrouz a. Forouzan, “Computer Networking –A Top-Down Approach” McGraw-Hill 2012

- William Stallings, " Data and Computer Communications", (8e), Prentice Hall of India Pvt. Ltd., 2006
- Behrouz A. Forouzan , "TCP/IP Protocol Suite" (5e), McGraw-Hill 2010
- Achyut S. Godbole, "Data Communications and Network", Tata McGraw-Hill 2002.

COMPILER DESIGN

ICS 362 **3-1-3- 5**

INTRODUCTION: Language Processors, The Structure of a Compiler- Lexical Analysis, Syntax Analysis, Semantic Analysis, Intermediate Code Generation, Code Optimization, Code Generation, Symbol-Table Management. (3 hours)

LEXICAL ANALYSIS: The Role of the Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, Finite Automata, From Regular Expression to Automata- Conversion of an NFA to a DFA, Construction of an NFA from a Regular Expression. (10 hours)

SYNTAX ANALYSIS:Introduction, Context-Free Grammars, Writing a Grammar- Lexical versus Syntactic Analysis, Eliminating Ambiguity, Elimination of Left Recursion, Left Factoring, Top-Down Parsing, Bottom-Up Parsing- Reductions, Handle Pruning, Shift-Reduce Parsing, Introduction to LR parsing- Simple LR, Why LR Parsers?, Items and LR(0) Automaton, The LR-Parsing Algorithm, Constructing SLR-Parsing Tables, More Powerful LR parsers- Canonical LR(1) Items, Constructing LR(1) Sets of Items, Canonical LR(1) Parsing Tables, Constructing LALR parsing tables. (14 hours)

SYNTAX DIRECTED TRANSLATION: Syntax-Directed Definitions, Evaluation Order for SDD's- Dependency Graphs, Ordering the Evaluation of Attributes, Applications of Syntax-Directed Translation -Construction of Syntax Trees. (5 hours)

INTERMEDIATE CODE GENERATION:Variants of Syntax Trees, Three Address Code-Addresses and Instructions, Quadruples and Triples, Types and Declarations- Type Expressions, Type Equivalence, Declarations, Translation of Expressions- Operations Within Expressions. (6 hours)

CODE GENERATION: Issues in Design of Code Generator, The Target Language, Basic Blocks and Flow Graphs, Optimization of Basic Blocks- The DAG Representation of Basic Blocks, Peephole Optimization. (7 hours)

RUN TIME ENVIRONMENTS:Storage Organization, Stack Allocation of Space- Activation Trees, Activation Records. (3 hours)

COMPILER DESIGN LABORATORY:

Preliminary Scanning Applications, Identification of tokens in a given program, Design of Lexical Analyzer, Design of parser, Design of code generator

TEXT / REFERENCES:

- Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers Principles, Techniques and Tools", (2e), Pearson Education, 2010.

- Kenneth C. Louden, “Compiler Construction - Principles and Practice”, (1e), Thomson, 2007.
- John R. Levine, Tony Manson, Doug Brown, “LEX & YACC”, (2e), O Reilly Media, 2012.
- Jeffrey D. Ullman, Rajeev Motwani and John E. Hopcroft, “Introduction to Automata Theory, Languages, and Computation”, (3e), Pearson, 2006.

ELECTIVE - I

ICS 363 **3-0-0-3**

BIG DATA ANALYTICS:

INTRODUCTION: Types of digital data, Introduction to Big Data and Big Data Analytics. (2 hours)

NOSQL: Introduction to NoSQL, Types and Advantages of NoSQL, Comparison of SQL, NoSQL and NewSQL, MongoDB: Features, Data types, Query Language; Cassandra: Features, Data types, Query Language (8 hours)

HADOOP: Core Hadoop components, Hadoop Ecosystem, YARN and MapReduce, Understanding I/O in MapReduce, Processing common serialization formats, Big data serialization formats, Organizing and optimizing data in HDFS, MapReduce with NOSQL as a data source, Applying MapReduce patterns to Big Data (14 hours)

BEYOND MAPREDUCE: Hive: Basics, Architecture, Data Types, File Formats, Query Language User Defined Function; Pig: Introduction, Pig Latin, Data Processing operators; Data stream processing with Spark (12 hours)

TEXT / REFERENCES:

- Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley India Pvt. Ltd., 2015
- Alex Holmes, "Hadoop in Practice", (2e), Manning Publications, 2015.
- Tom White, "Hadoop: The definitive guide", (4e), O’reilly, Yahoo Press, 2015.
- Pramod J Sadalage , Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", (1e), Addison-Wesley , 2012.

COMPUTER GRAPHICS:

Introduction: Introduction to computer graphics, Output technology – Video display devices, Raster scan systems, Random scan systems, Graphics Software; line drawing algorithms, circle and ellipse generating algorithms, clipping operations – point, line, and polygon clipping algorithms, filling algorithms. (8 hours)

Geometrical Transformation And Viewing : Two dimensional geometric transformations – Matrix representations and homogeneous coordinates, composite transformations; Two dimensional viewing – viewing pipeline, viewing coordinate reference frame; window-to-viewport coordinate transformation, Three Dimensional geometric transformations- 3D matrix representation, Composition of 3D transformations, Three dimensional viewing – viewing pipeline, viewing coordinates, Viewing in 3D- Projections, Mathematics of planar geometric projections. (10 hours)

Representing Curves And Visible Surface Determination: Parametric continuity conditions, Geometric continuity conditions, Hermite curves, Bazier curves. Visible surface detection methods-classification, Algorithms-z-buffer algorithm, List priority algorithm, Scan line algorithm, Area sub division algorithm. (8 hours)

Illumination And Color Models: Light sources – basic illumination models, Phong model, Assigning Intensity levels, Gamma Correction, Halftone patterns and dithering techniques, Properties of light – Standard primaries and chromaticity diagram; Intuitive colour concepts – RGB colour model – YIQ colour model – CMY colour model – HSV colour model – HLS colour model. (6 hours)

Surface Rendering Methods And Animations: Ray tracing methods, Basic ray tracing algorithm, Animation: Conventional and Computer Assisted animation, Animation Languages, Methods of controlling Animation, Basic rules of animation. (4 hours)

TEXT / REFERENCES:

- John F. Hughes, Andries Van Dam, Morgan Mc Guire ,David F. Sklar , James D. Foley, Steven K. Feiner and Kurt Akeley ,"Computer Graphics: Principles and Practice", (3e), Addison- Wesley Professional,2013
- Donald Hearn and Pauline Baker M, "Computer Graphics", Prentice Hall, New Delhi, 2007
- Donald Hearn and M. Pauline Baker, Warren Carithers, "Computer Graphics With Open GL", (4e), Pearson Education, 2010.
- Jeffrey McConnell, "Computer Graphics: Theory into Practice", Jones and Bartlett Publishers, 2006.

ELECTIVE - II

ICS 364 **3-0-0-3**

PRINCIPLES OF CRYPTOGRAPHY:

INTRODUCTION:Security Goals, Cryptographic Attacks, Services and Mechanisms, Techniques (2 hours)

CLASSICAL ENCRYPTION TECHNIQUES:Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Block Ciphers and the Data Encryption Standard- Block Cipher Principles, The Data Encryption Standard (DES), DES Example, The Strength of DES, Block Cipher Operation- Multiple Encryption and Triple DES, Electronic Codebook Mode, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode (10 hours)

MATHEMATICS OF CRYPTOGRAPHY: Modular Arithmetic, Modulo operator, Set of Residues, Congruence, Operations in Z_n, Inverse, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem. Basic concepts in number theory, Divisibility and The Division Algorithm, The Euclidean Algorithm, Modular Arithmetic. (6 hours)

ADVANCED ENCRYPTION STANDARD: The Origin of AES, AES Structure, AES Round Functions, AES Key Expansion, an AES Example (3 hours)

PSEUDORANDOM NUMBER GENERATION AND STREAM CIPHERS: Principles of Pseudorandom Number Generation, Pseudorandom Number Generators, Pseudorandom Number Generation Using a Block Cipher, Stream Ciphers, RC4 (4 hours)

PUBLIC-KEY CRYPTOGRAPHY AND RSA: Introduction, Principles of Public-Key Cryptosystems, The RSA Algorithm, Diffie-Hellman Key Exchange, ElGamal Cryptosystem, Elliptic Curve Arithmetic, Elliptic Curve Cryptography (6 hours)

CRYPTOGRAPHIC HASH FUNCTIONS: Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Requirements and Security, Hash Functions Based on Cipher Block Chaining, Secure Hash Algorithm (SHA), SHA-3, Message Authentication Requirement, Message Authentication Function, Message Authentication Codes,Digital Signatures. (5 hours)

TEXT / REFERENCES:

- William Stallings-"Cryptography and Network Security: Principles and Practice", (6e), Prentice Hall, 2014.
- Behrouz A. Forouzan and Debdeep Mukhopadhyay – "Cryptography and Network Security",(3e), McGraw Hill, 2015.
- Atul Kahate- "Cryptography and Network Security", Tata McGraw-Hill Publishing, 2008

MOBILE APPLICATION DEVELOPMENT:

GETTING STARTED WITH MOBILITY: Mobility landscape, Mobile platforms, Mobile apps development, Overview of Android platform, setting up the mobile app development environment along with an emulator, a case study on Mobile app development (4 hours)

BUILDING BLOCKS OF MOBILE APPS: App user interface designing – mobile UI resources (Layout, UI elements, Drawable, Menu), Activity- states and life cycle, interaction amongst activities. App functionality beyond user interface - Threads, Async task, Services – states and life cycle, Notifications, Broadcast receivers, Telephony and SMS APIs (8 hours)

DATA HANDLING IN MOBILE APPS: Native data handling – on-device file I/O, shared preferences, mobile databases such as SQLite, and enterprise data access (via Internet/Intranet), Content Providers (6 hours)

GRAPHICS AND MULTIMEDIA: Graphics and animation – custom views, canvas, animation APIs, multimedia – audio/video playback and record, working with images and camera (6 hours)

LOCATION AWARENESS AND SENSORS IN MOBILE APPS: Adding Support for location based services and native hardware access (sensors such as accelerometer and gyroscope), maps, android sensor framework, motion, position and environment sensors. (6 hours)

TESTING MOBILE APPS AND TAKING APPS TO MARKET: Debugging mobile apps, White box testing, Black box testing, and test automation of mobile apps, JUnit for Android, Robotium, MonkeyTalk, Versioning, signing and packaging mobile apps, distributing apps on mobile market place. (6 hours)

TEXT / REFERENCES:

- Anubhav Pradhan, Anil V Deshpande , "Composing Mobile Apps , learn, explore apply using Android", (1e), Wiley India Pvt. Ltd., 2014.
- Zigurd Mednieks, Laird Dornin, G. Blake Meike, and Masumi Nakamura, "Programming Android", (2e), O'Reilly, 2012
- Barry burd , "Android Application Development All in one for Dummies", (2e), John Wiley and Sons Inc., 2012

ELECTIVE - III

ICS 365 **3-0-0-3**

DIGITAL IMAGE PROCESSING:

INTRODUCTION: Fundamental Steps in Digital Image Processing, Fields that use Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sampling and Quantization, Basic Relationships between Pixels. (3 hours)

SPATIAL DOMAIN: Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods. (7 hours)

FILTERING IN THE FREQUENCY DOMAIN: Introduction to the Fourier Transform and the Frequency Domain, The Basics of Filtering in the Frequency Domain, Image Smoothing Using Frequency Domain Filters, Image Sharpening Using Frequency Domain Filters. (6 hours)

IMAGE RESTORATION: Noise models, Restoration in the presence of noise only spatial filtering, Periodic noise reduction by frequency domain filtering, Estimating the Degradation Function. (6 hours)

MORPHOLOGICAL IMAGE PROCESSING:Preliminaries, Dilation and Erosion, Opening and Closing, The hit-or-miss transformation, Some basic Morphological algorithms, Extension to Gray-Scale Images (6 hours)

IMAGE SEGMENTATION: Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation, Segmentation Using Morphological Watersheds, Use of Motion in Segmentation (8 hours)

TEXT / REFERENCES:

- Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", (3e), Prentice Hall, 2008.
- Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", (2e), Second Edition, Tata McGraw Hill Publication, 2010
- Sonka, Hlavac, Boyle, "Digital Image Processing and Computer Vision", Cengage Learning, 2008.

SOFTWARE TESTING AND ANALYSIS:

FUNDAMENTALS OF TEST AND ANALYSIS: Software Test and Analysis in a Nutshell – Engineering Processes and Verification, Basic questions, When Do Verification and Validation Start and End, Techniques to be applied, A Framework for Test and Analysis – Validation Verification, Degrees of Freedom, Varieties of Software. (2 hours)

FUNCTIONAL TESTING OVERVIEW: Boundary Value Testing, Equivalence Class Testing, Decision Table-Based Testing. (10 hours)

STRUCTURAL TESTING: Overview, Statement Testing, Branch Testing, Condition Testing, Path testing, Procedure call testing. (5 hours)

DEPENDENCE AND DATA FLOW MODELS: Definition-Use Pairs, Data Flow Analysis with Arrays and Pointers, Data flow testing: Overview, Definition-Use Associations, and Data Flow Testing Criteria. (5 hours)

MODEL-BASED TESTING: Overview, Deriving Test Cases from Finite State Machines, Testing Decision Structures, Deriving Test Cases from Control and Data Flow Graphs. (5 hours)

TESTING OBJECT-ORIENTED SOFTWARE: Overview, Issues in Testing Object Oriented Software, Intra Class Testing, Interclass Testing, Polymorphism And Dynamic Binding, Inheritance, Genericity, Exceptions (4 hours)

TEST-ADEQUACY ASSESSMENT USING PROGRAM MUTATION: Introduction, Mutation and Mutants, Test Assessment Using Mutation, Mutation operators. (4 hours)

TEST EXECUTION: Overview, From Test Case Specifications to Test Cases, Scaffolding, Test Oracles, Capture And Replay (2 hours)

TEXT / REFERENCES:

- Mauro Pezze, Michal Young , "Software Testing and Analysis: Process, Principles and Techniques", John Wiley & Sons, 2008.
- Aditya P Mathur , "Foundations of Software Testing", Pearson Education 2013.
- Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications, 2013.
- Gopalaswamy Ramesh, Srinivasan Desikan, "Software testing Principles and Practices", (2e), Pearson, 2007.
- Ron Patton, "Software Testing", (2e), Pearson Education, 2006.

ELECTIVE - IV

ICS 366 **3-0-0-3**

PRINCIPLES OF PROGRAMMING LANGUAGES:

INTRODUCTION:What is a Programming Language?, Abstractions in Programming Languages, Computational Paradigms, Language Definition, Language Translation. (2 hours)
LANGUAGE DESIGN PRINCIPLES: History and Design Criteria, Efficiency, Regularity, Further Language Design Principles (2 hours)
SYNTAX: Lexical Structure of Programming Languages, Context-Free Grammars and BNFs Parse Trees and Abstract Syntax Trees, Ambiguity, Associativity, and Precedence EBNFs and Syntax Diagrams, Parsing Techniques and Tools, Lexics Versus Syntax Versus Semantics (6 hours)
BASIC SEMANTICS: Attributes, Binding, and Semantic Functions, Declarations, Blocks, and Scope, The Symbol Table, Name Resolution and Overloading, Allocation, Lifetimes, and the Environment, Variables and Constants, Aliases, Dangling References, and Garbage. (6 hours)

EXPRESSIONS AND STATEMENTS: Expressions, Conditional Statements and Guards, Loops and Variation on WHILE, The GOTO Controversy, Exception Handling. (4 hours)
OBJECT-ORIENTED PROGRAMMING: Software Reuse and Independence, Java: Objects, Classes, and Methods, Inheritance Dynamic Binding (3 hours)
FUNCTIONAL PROGRAMMING: Programs as Functions, Functional Programming in an Imperative Language, Scheme: A Dialect of LISP (4 hours)
LOGIC PROGRAMMING: Logic and Logic Programs, Horn Clauses, Resolution and Unification (3 hours)
PARALLEL PROGRAMMING:Introduction of Parallel Processing, Parallel Processing and Programming Languages, Threads, Semaphores, Monitors, Message Passing, Parallelism in Non-imperative Languages (6 hours)

TEXT / REFERENCES:

- Kenneth C. Louden, Kenneth A. Lambert, "Programming Languages Principles and Practice" (3e), Cengage Learning, 2012.
- Allen B. Tucker, Robert E. Noonan, "Programming Languages Principles and Paradigms",(2e), ,TMH, 2010.

- Terrence W. Pratt, Marvin V. Zelkowitz, "Programming Languages: Design and Implementation", (4e), 2001.

MACHINE LEARNING:

INTRODUCTION: Machine learning Introduction, supervised learning, unsupervised learning, Mathematical preliminaries, Review of linear algebra, probability theory review, overview of convex optimization, Hidden Markov model, Multivariate Gaussian distribution, Gaussian processes (6 hours)

CLASSIFICATION & REGRESSION: Bayesian decision theory, maximum likelihood ratio, parametric classification, regression, multivariate methods, K-nearest neighbour classification (10 hours)

SUPERVISED LEARNING: Supervised learning : Supervised learning setup LMS, Logistic regression, perceptron, exponential family, generative learning algorithms, Gaussian discriminant analysis, Naive Bayes, Support vector machines, Model selection and feature selection, Evaluating and debugging learning algorithms. (12 hours)
UNSUPERVISED LEARNING:Clustering K-means hierarchical clustering, competitive learning ,radial basis functions, EM, Mixture of Gaussians, Factor analysis, PCA (Principal components analysis),ICA(Independent component analysis) (8 hours)
GRAPHICAL MODELS:Naive Bayes classifier, Hidden Markov Model, Linear Regression , Belief propagation. (7 hours)
COMBINING MULTIPLE LEARNERS:Generating diverse learners ,Voting, error correcting output codes, Bagging, Boosting. (5 hours)

TEXT / REFERENCES:

- Kevin P Murphy, "Machine Learning :A probabilistic perspective" MIT press 2012.
- Ethem Alpaydin , "Introduction to Machine Learning" Second edition, MIT Press 2010.
- Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, "Foundations of Machine learning" MIT Press 2012.
- Daphine Koller and Nir Friedman, "Probablistic Graphicl models:Principles and techniques", MIT Press 2009.
- Christopher M Bishop, "Pattern recognition and Machine learning", Springer 2007.
- Richard O.Dudda, Peter E Hart, David G Stork, "Pattern Classification",(2e),Wiley,2001.

SEMINAR

ICS 367 **0-0-3-1**

Students need to present a seminar on a topic of recent developments in their subject filed.

B.Sc. (ELECTRICAL & ELECTRONICS)

II SEMESTER

III SEMESTER

ELECTROMAGNETIC THEORY

IEC 233 **3– 1– 0 – 4**

Review of Vector analysis: Review of basic vector algebra, Cartesian, cylindrical and spherical co-ordinate systems. (4 hours)

Electrostatics: Coulomb's law and its applications, Electric field intensity and Electrostatic potential due to point charges, line charge, surface charge and volume charge distribution. Electric flux and electric flux density, Gauss's law and its applications, divergence and Gauss divergence theorem, Ohm's law, continuity equations and relaxation time, capacitance, energy and energy density in electrostatic fields, boundary conditions: dielectric-dielectric, dielectric-conductor. Poisson's and Laplace's equations, solution to Laplace's equation (problems of one dimension). (14 hours)

Magnetostatics: Magnetic field intensity, Biot-Savart's law, magnetic flux and magnetic flux density, Ampere's law and its applications, Stoke's theorem, scalar and vector magnetic potentials, boundary conditions, magnetic dipole, Faraday's laws of electromagnetic induction,

motional induction in a conductor, torque on a conductor, self and mutual inductance, energy and energy density in a magnetic field. (10 hours)

Electromagnetic Waves: Maxwell's equations in integral and point form for free space and material media, for sinusoidal time-varying fields, electric and magnetic wave equations and their solutions, uniform plane wave propagation in various media, relation between electric and magnetic fields, characteristics of plane waves in various media, Poynting vector and complex Poynting vector theorem. (10 hours)
Reflection of Electromagnetic Waves: Normal incidence of plane waves from dielectric-dielectric and dielectric- conductor medium, Transmission and reflection coefficients and standing wave ratio, oblique incidence of plane waves, Brewster's angle, total reflection. (10 hours)

TEXT / REFERENCES:

- Jr. Hayt, Buck, "Engineering Electromagnetics" 7th Edition, McGraw Hill. 2011
- Martin A Plonus "Applied Electromagnetics" McGraw Hill, 1978.
- Sadiku, "Elements of Electromagnetics", 3rd Edition, Oxford University, 2012.
- R K Shevgaonkar, "Electromagnetic waves", Tata McGraw Hill, 2005.

MICROCONTROLLERS

IEE 234 **3– 1– 0 – 4**

Introduction to microprocessors and microcontrollers, Evolution of microprocessors and microcontrollers, Embedded system and general purpose systems, CISC and RISC architecture, Princeton and Vonneuman architecture. (3 hours)

The 8051 architecture, On chip features, Registers, Assembly language programming, 8051 instruction set, addressing modes, Programming using 8051 instruction set. (12 hours)
Pin diagram of 8051 microcontroller, signal description, oscillator and Reset circuit, I/O ports. (2 hours)
Timer/ Counter: Programming 8051 timers, counter programming. Serial communication: Basics of serial communication, RS232 serial communication standard, programming the 8051 serial port for data transmission and reception. (6 hours)

Interrupts: 8051 interrupts, programming timer interrupts, programming external hardware interrupts, programming the serial communication, interrupt priority. (4 hours)

System design using 8051: Interfacing keyboards, seven segment LED display, LCD display, ADC, DAC and stepper motor to 8051. (8 hours)
Programming 8051 in 'C', programming examples (including interfacing exercises). (5 hours)
Interfacing external memory to 8051,I/O expansion using PPI, 8255, Interfacing 8255 to 8051 and programming. (6 hours)
Development tools: Simulators, debuggers, assembler and compilers, linkers, in circuit emulators for microcontrollers. (2 hours)

TEXT / REFERENCES:

- Muhammad Ali Mazidi and Gillispie Mazidi, The 8051 Microcontroller and embedded systems, using assembly and 'C' , Pearson education, 2013.
- Kenneth. J. Ayala, The 8051 Microcontroller and embedded systems, using assembly and 'C', Cengage Learning, 2013.
- Ajay. V. Deshmukh, Microcontrollers theory and applications, TMH, 2007

IV SEMESTER

IHS 241 - ENGINEERING ECONOMICS & MANAGEMENT

(Refer page no. **45**)

IEC 241 - IC SYSTEMS (Refer page no.**67**)

IEE 241 - SIGNALS AND SIGNAL PROCESSING

(Refer page no.**68**)

ELECTIVE – I - VLSI DESIGN

IEC 243 **3- 1 -0 –4**

Introduction: VLSI technology trends, performance measures and Moore's law. (2 hours)

MOS devices and Circuits: MOS transistors study of depletion and enhancement mode operations, threshold voltage and numericals, second order effects in MOSFETs, analysis of NMOS and CMOS inverter circuits. (6 hours)
Fabrication of ICs: Lithographic process of MOS and CMOS fabrication, N-well, P-well and twin tub processes, Latch up in CMOS SOI process, VLSI yield and economics. (6 hours)

MOS Circuit design & Layouts: Pass transistors and transmission gates. Implementation of Boolean functions and combinational circuits using switch logic & gate logic. BiCMOS inverters and circuits, pseudo NMOS inverter, dynamic and clocked CMOS inverters. clocking strategies, flip flops and sequential circuits, dynamic memory elements, R/2 register stages. static and dynamic memory cells. RAM, ROM, PLA circuits for both combinational and sequential circuits. Stick diagrams, design rules and layouts for NMOS and CMOS, scaling of MOS circuits. (20 hours)

Basic circuit concepts and performance estimation: Sheet resistance, standard unit of capacitance, estimation of delay in NMOS and CMOS inverters, driving of large capacitive loads, super buffers, power dissipation in CMOS. (8 hours)
Sub system design: Design strategies, design issues and structured approach, design examples such as adders, ALUs and shifters, design of sequential circuits using dynamic memory elements. (8 hours)
Advanced Devices: Nano CMOS Technology, GaAs transistors. (4 hours)

TEXT / REFERENCES:

- Pucknell D. A. and Eshraghian K.,"Basic VLSI Design", PHI publication, 2009.
- Amar Mukherjee, "Introduction to NMOS & CMOS VLSI systems Design", Prentice Hall.
- Weste. N and Eshraghian K, "Principles of CMOS VLSI Design", 2nd Edition, Addison Wesley Publication.

- Sung Mo Kang and Yusuf leblebici, "CMOS digital Integrated circuits design and analysis", 3rd edition, Tata Mcgraw Hill.
- Saraju P. Mohanty and Ashok Srivastava,"Nano-CMOS and Post-CMOS Electronics: Devices and Modelling", Vol. 1.

ELECTIVE – I - POWER SYSTEM ANALYSIS

IEE 243 **3- 1 -0 –4**

Introduction, General layout of a power system, conventional ways of generating electric power.

Representation of power systems: One line diagram, impedance diagram, Thevenin's model, three-winding transformers. Admittance & impedance model for power systems & network calculation. (10 hours)

Symmetrical three-phase faults: Short circuit current and reactances of synchronous machines short-circuit current calculations, selection of circuit breakers, current limiting reactors. (8 hours)

Asymmetrical faults: Symmetrical components, sequence impedances and sequence networks of power systems, analysis of unsymmetrical faults in generators and power systems under no-load and loaded conditions. (13 hours)

Load flow studies-Load flow equations, solution by Gauss-Siedel and Newton-Raphson methods. (5 hours)

Stability studies: Steady-state and transient-state stability, swing equation, Equal area criterion, Numerical solution of Swing equation, critical clearing time. (10 hours)

Introduction to distributed generation systems. (2 hours)

TEXT / REFERENCES:

- Nagrath I.J. & D.P.Kothari, Modern Power System Analysis (3e), TMH, 2003.
- Grainger & Stevenson, Power System Analysis, TMH 2003
- Hadi Saadat, Power System Analysis, MGH, 1999.
- Khan B. H., Non-conventional Energy Resources, TMH, 2006

ELECTIVE – II - DIGITAL SYSTEM DESIGN USING VERILOG

IEC 244 **3- 1 -0 –4**

Digital Implementation Options and Design Flow: Design styles: Full-custom, Semi-custom, Programmable ASICs: CPLDs, MPGAs and FPGAs, Y-chart, Design flow, Logic synthesis. (6 hours)

FPGA Architectures and Applications: Architecture of ACTEL, XILINX and ALTERA logic families, Logic module, Switching technology. Implementation of combinational and sequential circuits using FPGAs: Shannon's decomposition. (10 hours)

Digital Testing and Testability: Fault models, path sensitization and D algorithms, Boolean difference, PODEM, ITG, DFT methods: Ad-hoc and scan path. (10 hours)

Introduction to Verilog: Introduction to HDL, VHDL versus Verilog, Verilog description of combinational circuits. Verilog modules. Verilog assignments. Procedural assignments. Modeling flip-flops using always block. Always blocks using event control statements. Delays in Verilog. Compilation, simulation, and synthesis of Verilog code. Verilog data types and

operators. Simple synthesis examples. Verilog models for multiplexers. Modeling registers and counters using Verilog always statements. Behavioral, switch level, data flow and structural models. Constants. Arrays. Loops in Verilog. Testing Verilog model. Verilog functions. Verilog tasks, Named association. Generate statements. (18 hours)

System level design using Verilog: System level design of real-world examples using Verilog such as seven segment LED displays, ALU and UART. (4 hours)

TEXT / REFERENCES:

- Charles Roth, Lizy Kurian John, Byeong Kil Lee, Digital System Design Using Verilog, 1st Edition, 2016.
- Michael D. Ciletti, Advanced Digital Design with the Verilog HDL, Prentice Hall Publishing, Second edition, 2010.
- Stephen. Brown and Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design, TMH, 2013.
- Parag K. Lala, Fault tolerant and Fault testable hardware design, BS Publication, 1990.
- M. J. S. Smith, Application Specific ICs, Pearson 1997.

ELECTIVE – II - ELECTRICAL MACHINES

IEE 244 **3- 1 -0 –4**

D.C. Machines: Construction, principle of generator and motor, emf equation, types, characteristics; torque equation, speed control, starter, testing. (8 hours)
Transformers: types, principle, equivalent circuit, O.C and S.C. tests, losses, efficiency and regulation, All-day efficiency, polarity test, Parallel operation, tap changers, Auto-transformer; Connection of single phase transformers for three phase operation. (10 hours)
Three phase induction motors: types, principle, equivalent circuit, no-load and blocked rotor tests, induction generator, starting, Speed control. (8 hours)
Synchronous machines: Constructional features, e.m.f. equation, Armature reaction: Effect of power factor on armature reaction - Non-salient pole alternator: Synchronous impedance, O.C. and S.C. characteristics - Power input & power output, voltage regulation. Synchronization: Governor characteristics, alternator connected to infinite bus, Salient pole alternator: Two reaction theory, Phasor diagram, voltage regulation, slip test power angle characteristics. (12 hours)
Synchronous motors: Principle of operation, power input and power developed, performance characteristics, V- curve, inverted V curve, synchronous condenser, methods of starting, Synchronizing power and torque, hunting, periodicity of hunting, damping. (10 hours)

TEXT / REFERENCES:

- P. S. Bimbhra, Electrical Machinery (7e), Khanna publishers, 2012
- D. P. Kothari & I. J. Nagrath, Electric Machines (4e), TMH, 2013
- Langsdorf E.H., Theory of Alternating Current Machinery (2e), TMH, 2004
- Say M. G., Alternating Current Machines (5e), ELBS, 1994
- Mukherjee P. K. & Chakravarti C, Electrical Machines (2e), Dhanpat Rai & Sons, 2005

MICROCONTROLLER LABORATORY

IEE 242 **0- 0 -6 –2**

Assembly language Programming in 8051 using Keil software:

- Data Transfer, Block move & Branching Instructions.
- 8-Bit Arithmetic and Logical operations.
- BCD, Multibyte and other Arithmetic operations.
- Searching and Sorting.
- Counters and Code conversions.

Introduction to 8051 Microcontroller kit
Interfacing Exercises using Assembly Language Programming:

- Interrupts.
- Interfacing DAC with 8051.
- Interfacing LCD for message display and Interfacing Hex key pad to 8051.

Interfacing Exercises using High Level Language 'C' programming:

- Interfacing ADC with 8051.
- Interfacing Stepper Motor with 8051.

Mini project using 8051 microcontroller [Assembly / 'C' language].

TEXT / REFERENCES:

- Muhammad Ali Mazidi and Gillispie Mazidi, The 8051 Microcontroller and embedded systems, using assembly and 'C' , Pearson education, 2013.
- Kenneth. J. Ayala, The 8051 Microcontroller and embedded systems, using assembly and 'C', Cengage Learning, 2013.
- Ajay. V. Deshmukh, Microcontrollers theory and applications, TMH, 2007

V SEMESTER
PROJECT WORK

IEC / EE 351 **0-0-36-12**

Students need to form batches with maximum four in numbers and required to identify the problem in their area of interest within their discipline of study under the supervision of a faculty (Guide) for 12 to 14 weeks. At the end, the findings need to be presented in the form of a project report for final evaluation.

VI SEMESTER
LINEAR AND DIGITAL CONTROL SYSTEMS

IEC 361 **3-1-0-4**

Block diagrams and signal flow graphs: Transfer function, block diagram, simplification of systems, signal flow graphs, gain formula, state diagram, transfer function of discrete data systems, zero order hold. (7 hours)

System modeling: Modeling of electrical and mechanical systems (translational & rotational), system equations, and its electrical equivalent (analogous) networks. (7 hours)
Time domain analysis: Stability, Routh-Hurwitz criterion, time response for continuous data systems, type and order of systems, steady state error for linear systems, unit step response for second order systems, root locus properties and construction. (9 hours)
Frequency domain analysis: Introduction, second order prototype system, Bode diagram, gain and phase margins, Nyquist stability criterion. (7 hours)
Compensators and controllers: Feedback and feed forward controls, proportional, integral, PI, PD and PID controllers, lead, lag and lead-lag compensators. (7 hours)
Digital control systems: Mapping between s and z plane, Jury's test, bilinear transformation, steady state error. (3 hours)
Controllers: Z transform based control algorithms, PID controllers – direct digital controllers. (4 hours)
State space representation: Stability analysis, state transition matrix, Eigen values, controllability and observability. (4 hours)

TEXT / REFERENCES:

- B. C. KUO, "Automatic Control Systems", 7th edition, PHI.
- Nagrath and Gopal, "Control system engineering", 3rd edition, PHI.
- K.Ogata, "Modern control engineering", 2nd edition, PHI.
- D'azzo and Houpis, "Linear Control System Analysis and Design", 5th edition, TMH, 2003.
- S. I. Ashon, "Microprocessors with applications in process control", McGraw Hill, 1984.

MEASUREMENTS AND INSTRUMENTATION

IEE 361 3-1-0-4

Basic concepts of measurements: System configuration, problem analysis; Case Study: ECG Monitoring System; Virtual Instrumentation: Basic concepts; Introduction to LABVIEW: Basic Features; Basic characteristics of measuring devices and instrumentation system: Static and Dynamic characteristics, Sources of Errors/ Calibration. (6 hours)

Transducers: Active/Passive, Mechanical/Electrical, Basic requirements of a transducer, Classification, characteristics, selection; Electrical transducers: variable resistance transducers - strain gauges, Variable capacitance transducers, Variable inductive transducers – LVDT, Hall-effect, semiconductor, Opto-electric, Piezo-electric transducers (Principle of operation, advantages and disadvantages, application. (8 hours)

Analog signal conditioning: Basic blocks – Signal isolation; filters- Noise cancellation filters – configurable universal filters; level shifters; sample and hold; Instrumentation amplifiers; modulators & demodulators; v/f and i/f converters. (4 hours)

Data conversion: Accuracy, resolution, conversion time, settling time; DAC–weighted resistor D to A converter, R-2R ladder network; ADC – Successive approximation, integrating, Flash ADC. (4 hours)

Signal transmission: Digital data transmission, classification, types of protocols, clock extraction, Multiplexing; Bus protocols – RS 232, IEEE 488, CAN bus, USB, Bluetooth, GPS, Ethernet. (6 hours)

I/O Devices: Analog displays and recorders, digital I/O devices; Measurement Displays: Electro-Mechanical Displays & Electro-Optic Displays, seven segment, dot-matrix display, LED, LCD; RECORDING: Graphical recording, Magnetic recording, Electro-optic recording; displays. (4 hours)

Oscilloscopes: Oscilloscope function, Types; Digital storage oscilloscopes; Measurements using CRO: dual mode, x-y mode, Lissajous patterns. (4 hours)

Measuring Instruments: Permanent Magnet Moving Coil, Moving Iron andElectro-dynamometer Type, Applications. (4 hours)

Measurement of Resistance, Inductance & Capacitance: AC Bridges. (4 hours)
Instrument Transformers: CT and PT. (2 hours)
Virtual Instrument: Implementation issues; Choice of Data Acquisition Cards; Case study - Digital multi-meter, Digital frequency meter, Digital Energy Meter. (2 hours)

TEXT / REFERENCES:

- Sawhney A.K., A course in Electrical and Electronic Measurements and Instrumentation (4e), Dhanpat Rai& Sons, 1991.
- Golding E.W. &Widdis F.C., Electrical Measurements and Measuring Instruments (5e), Wheeler, 1989.
- Rangan, Sarma, & Mani, Instrumentation Devices and Systems (2e), TMH, 1998.

MEASUREMENTS AND INSTRUMENTATION LABORATORY

Design & implementation of measurement systems on microcontroller platform - Sensing power signals -Sensing ECG signal - Realisation of instruments such as volt meter, ammeter, wattmeter .
Design & Realisation of common analog signal conditioning blocks using Analog System

Design starter kit - ASLKv2010 - Study of ADC & DAC - Real time data acquisition, measurement & monitoring on Virtual instrumentation platform.

TEXT / REFERENCES:

- Rangan, Sarma, & Mani, Instrumentation Devices and Systems (2e), TMH, 1998
- K R K Rao , C P Ravikumar, Analog System Lab Manual, TexasInstruments,WileyIndia
- Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI,2010

ELECTIVE – III

IEC/IEE 362 3-0-0-3

ANALOG COMMUNICATION:

Spectral analysis: Review of Fourier theory, Energy spectral density, power spectral density, auto correlation and cross correlation of energy and power signals, spectral characteristics of periodic signals. (5 hours)

Amplitude modulation: Introduction, time and frequency domain analysis, modulation index for sinusoidal AM, average power for sinusoidal AM, effective voltage and current for sinusoidal AM, single tone AM, AM by several sine waves. Generation of AM using square law modulator and switching modulator, detection of AM using square law detector and envelope detector, super-hetrodyne receiver. (8 hours)

Double Side Band Suppressed Carrier (DSBSC) Modulation: Introduction, time and frequency domain analysis, generation using balanced modulator and ring modulator, coherent detection, Costas loop, quadrature carrier multiplexing. (4 hours)

Single Side Band (SSB) Modulation: Introduction, time and frequency domain analysis, generation using filter method and phase discrimination method, coherent detection, FDM, VSB modulation. (4 hours)

Angle modulation: Introduction to phase modulation (PM) and frequency modulation(FM), FM time and frequency domain analysis, modulation index for sinusoidal FM, average power for sinusoidal FM, single tone FM, generation of FM using direct method and indirect method, detection of FM using slope detector, zero cross detector and phase locked loop, amplitude limiters in FM, automatic frequency control (AFC), FM stereo transmitter and receiver, FM receiver, pre-emphasis and De-emphasis filters. (8 hours)

Noise: Introduction, thermal noise, shot noise, signal to noise ratio (SNR), SNR of a tandem connection, noise factor, amplifier noise in terms of F, noise factor of amplifiers in cascade, noise factor and equivalent input noise generators, noise factor of a lossy network, noise equivalent temperature, narrow band pass noise, noise in AM system, noise in AM DSBSC system, noise in SSB system, pre-emphasis and de-emphasis in FM, noise in FM system. (7 hours)

TEXT / REFERENCES:

- Simon Haykin, "An Introduction to Analog & Digital Communications", Willey Eastern, New York, 2009.
- Taub and D. L. Shelling, "Principles of Communication systems", McGraw Hill Book Co., 2008.
- B. P. Lathi, "Modern Digital and Analog Communication", Oxford University Press, 2005.
- Cooper and McGillem, "Statistical Probabilistic methods for Signals and System Analysis" Oxford University Press, 2007.
- Dennis Roddy & John Coolen, "Electronic Communications" Fourth Edition, PHI, 2001

SOLID STATE LIGHTING AND CONTROLS:

Introduction to Lighting Technology: Lighting fundamentals, terminologies, generation of radiation, CCT, CT, CRI, CIE Chromaticity diagram, Light generation principles– Incandescence & luminescence, Classification, Review of light sources-evolution. (4 hours)

Solid state lamps: SSL basics, life cycle of a photon, Photon emission in LEDs, Photon efficiency, Optical Characteristics of LED– Light Escape Cone, Lambertian pattern, methods to increase extraction efficiency, numerical. (4 hours)

White Light Generation: Characterization of LEDs for illumination application- low, medium and high Power LEDs, Techniques – Blue Chip with Phosphor, UV with several phosphor & RGB LEDs, advantages, disadvantages, challenges and color issues of white LEDs. (4 hours)

Electrical Characteristics of LEDs: V-I Characteristics, current controlled and voltage controlled source, advantages and disadvantages, current limiting techniques, Types of regulators-linear-active and passive current sources, switch mode, advantages and disadvantages. (6 hours)

LED driver design: Power management topologies (switch mode) – Buck, Boost, Buck Boost, applications, Numerical. (5 hours)

LED Dimming and control: Types-analog, digital, advantages, disadvantages, applications, Color control feedback schemes – Temperature Feed Forward, Flux Feed Back, TFF & FFB & Color Coordinate Feedback, advantages and disadvantages. (6 hours)
Thermal management of LEDs: Significance, causes, Thermal Resistance, Thermal Resistance Model with heat flow path, Factors considered for heat sink selection, heat sink design considerations, Numerical, SSL testing standards, Data sheet analysis for optimal design and product selection. (4 hours)
Remote Phosphor Technology: Construction & advantages, OLED – Principle, types, application & advantages. (3 hours)

TEXT / REFERENCES:

- Arturas Zukauskus, Michael S. Shur and Remis Gaska, "Introduction to solid state lighting", Wiley-Interscience, 2002.
- E. Fred Schubert, "Light Emitting Diodes" (2nd edition), Cambridge University Press, 2006.
- Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and Sons, 1989
- Steve Winder, "Power Supplies for LED Driving" Newnens Publication, 2008
- Extract from Current Literature

MATLAB FOR ENGINEERING:

Introduction to MATLAB: Numeric, Cell, and Structure Arrays - Functions and Files - Decision-Making Programs - Linear Algebraic Equations- data processing and visualization- (10 hours)
Data handling & plotting: Importing & organizing data - Advanced Plotting. (4 hours)

Siumulink: System Dynamics, Model Building and Regression; curve fitting & interpolation; ODE & PDE Solvers; Simulation of linear models of mechanical and electrical systems using Simulink; data acquisition and analysis; building GUI; Converting MATLAB code to executable format. (16 hours)

Project based learning: Building interactive applications (demos & mini project). (6 hours)

TEXT / REFERENCES:

- Hanselman, Mastering MATLAB 7, Pearson Education 2005.
- www.mathworks.com

DIGITAL SIGNAL PROCESSING:

Z-transform and its application to the analysis of LTI systems: Review of time and frequency analysis of signals and systems. Review of Z - transform, analysis of LTI system in Z - domain,

system function, pole-zero analysis, stability, unilateral Z - transform, solution of difference equations. (6 hours)

Discrete Fourier Transform: Frequency domain sampling and reconstruction of discrete time signals – DFT, properties of DFT, use of DFT in linear filtering, filtering of long data sequences, DFT as linear transformation, efficient computation of DFT. FFT algorithms, radix 2 DITFFT and DIFFFT, in - place computation, pipeline FFT, Goertzel algorithm. (8 hours)

Implementation of Discrete time filters: Structures for FIR filters – Direct form, cascade form, frequency sampling and lattice structures. Structures for IIR filters – Direct forms, cascade and parallel form, lattice ladder structures. Finite word length effects. (6 hours)

Design of IIR and FIR filters: Classical design by impulse invariance, bilinear transformation and matched Z - transform, characteristics and design of commonly used filters - Butterworth, Chebyshev and elliptic filters. Spectral transformation, direct design of IIR filters. Linear phase FIR filters - symmetric and anti-symmetric impulse response. Design of FIR filters using windows, frequency sampling design. (10 hours)
Power spectrum estimation: Effect of time domain windowing on power spectrum, non-parametric methods of PSD estimation- Periodogram, Bartlett, Welch and Blackman-Tukey methods (qualitative analysis only). Parametric methods of PSD estimation - AR, ARMA and MA modeling (qualitative analysis only). (6 hours)

TEXT / REFERENCES:

- Proakis J. G, Manolakis D. G. Mimitris D., "Introduction to Digital Signal Processing" Prentice Hall, India, 2003.
- Oppenheim A.V, Schafer R. W, "Discrete Time Signal Processing", Pearson Education, 2003.
- Ifeachar, Jervis, "Digital Signal Processing - A Practical approach", Pearson Education, Asia, 2003.
- Rabiner L. R, Gold D. J, "Theory and applications of digital signal processing", Prentice Hall, India, 1998.
- Sanjit Mitra K, "Digital Signal Processing - A computer based approach", TMH, 2001.

ELECTIVE – IV

IEC/IEE 363 3-0-0-3

DIGITAL COMMUNICATION:

Signal detection: Model of digital communication system, Gram-Schmidt orthogonalization procedure, geometric interpretation of signals, response of bank of correlators to the noisy input, detection of known signals in noise, probability of error, correlation receiver, matched filter receiver. (5 hours)
Pulse modulation systems: Pulse amplitude modulation (PAM), band width requirements and reconstruction methods, time division multiplexing, pulse duration modulation (PDM), generation of PDM signals and reconstruction methods. Sampling, quantization and encoding techniques, application to pulse code modulation (PCM), quantization noise in PCM, companding in PCM systems, Time division multiplexing (TDM) and examples of PAM and PCM systems. The T1 PCM system in telephony. The delta modulator and its operation, quantization noise and slope overload in delta modulators. Comparison of delta modulation and PCM. (8 hours)

Baseband digital data transmission: Baseband digital communication systems, multilevel coding using PAM, pulse shaping and band width consideration, inter symbol interference (ISI). Nyquist condition for zero ISI, band limited Nyquist pulses, the eye diagram. Duo binary and modified duo binary encoding, Optimum detection of a Baseband data communication systems. Performance limitation of Baseband data communication due to noise probability of error expression for multi-level data signals. (6 hours)

Digital modulation techniques: Band pass (modulated) digital data systems, binary digital modulation, PSK, DPSK, and FSK. Mary data communication systems, quadrature amplitude modulation (QAM), systems, QPSK, OQPSK, and MSK. Introduction to OFDM. Effects of noise in modulated digital communication systems, optimum binary systems. Probability of error expression for binary (coherent and non coherent) communications, probability of error in QAM systems, comparison of digital modulation systems, Application of modems for transmission over telephone lines. (10 hours)

Spread Spectrum System (SSS): PN sequences and its properties, Direct sequence SSS, frequency hopping SSS. Applications – Ranging multi path, CDMA (7 hours)

TEXT / REFERENCES:

- Haykin S, "Digital Communications" John Wiley and Sons, 1988.
- Taub H and Schilling D. L, "Principles of Communication systems", McGraw Hill publication, 2008.
- Hsu H.P., "Analog and Digital Communications", Schaum's outline series, 2003.
- Proakis J G, "Digital communications" McGraw Hill, 2009.
- Cooper and McGillem "Statistical Probabilistic methods for Signals and System Analysis", Oxford University Press, 2007.

LIGHTING SCIENCE: DEVICES AND SYSTEMS:

Light and vision: Electromagnetic spectrum – Visible spectrum – Anatomy of eye – Rods and Cones, Visual process – Spectral eye sensitivity – Photopic, Scotopic and Mesopic visions – Colour vision, Reflection – Types, Examples. (3 hours)

Photometric quantities and units: Definitions of Luminous flux, Luminous intensity, Illuminance, Luminance – Laws of illuminance: Inverse square law, Lambert's cosine law – Relation between photometric quantities. Luminous efficacy – Light watt – Luminous exitance – Difference between luminance and brightness – Comparison of Photometric and Radiometric quantities, Point by Point method – Horizontal illuminance – Vertical illuminance – Limitations of Point by Point method and tutorials. (5 hours)

Artificial light source: Sources of Radiation – Generation of radiation – Coherent and in-coherent radiations – Incandescence – Luminescence, Thermal radiators – Black body radiator (BBR), Laws of BBR, Colour temperature – correlated colour temperature – colour appearance – colour rendering, Low pressure gaseous discharge – VI characteristics – Glow discharge – Arc discharge – High pressure arc discharge, Construction, Principle of operation, Performance characteristics (Luminous efficacy, Lamp life and Colour characteristics) – Applications of (i) Incandescent lamp ii) Tungsten-Halogen lamp (iii) Fluorescent lamp (iv) CFL (v) MH lamp and mercury lamp and (vi) LED and etc. (9 hours)

Luminaires: Definition – Desired functions – Light control elements – Applications of light control element, Reflectors – Reflection patterns in Circular and Parabolic reflectors, Light distribution – Classification – Symmetrical and Asymmetrical – Diffused and Focused – Direct and Indirect (CIE classification), LID diagrams – Rectangular and Polar – Measurements using Gonio Photometer – Four fundamental techniques. (4 hours)

Interior lighting design: Objectives – Factors affecting the performance of lighting system (Size and shape of the room, reflectance, windows, maintenance, temperature and objects in the environment), Types of lighting methods, Design Terminologies: LDL,LOR, DLOR, ULOR, UFF, LFF, FFR and Photometric test data – Zonal factor – Calculation of total luminous flux output (Zonal integration method), Define CU, CU calculation methods and Lumen method of lighting design for average illuminance – Luminaire layout - Spacing to Mounting Height ratio, design lighting layout for an various interior lighting applications, Glare – Types of glare – Direct, Indirect and Reflected glares – Veiling reflections – Methods to reduce glare and evaluation of glare, Complete energy efficient lighting solution to meet quantity and quality of illuminance as per standards. (11 hours)

Lighting controls: Lighting control strategies: Occupancy sensor - Load scheduling – Dimming control, Commissioning & LEED, Energy codes (ASHRAE/IESNA & IECC), Design patterns to different applications: (i) Auditoriums (ii) Class rooms (iii) Conference room etc. (4 hours)

TEXT / REFERENCES:

- New York, "lighting Handbook", (10e), 2011.
- Spiros Kitsinelis, " Light source: Technologies and Applications", CRC press, 2010
- M.A. Cayless and A.M Marsdon, "Lamps & Lighting", (4e) Oxford & IBH publishing company, 1996.
- Jack L. Lindsey, "Applied illumination En ESNA Engineering", (2e), Fairmont press, INC1997.
- D.W. Durrant, "Interior Lighting Design" Ed.5, L.I.F., London, 1977.
- Robert S Simpson, Lighting Controls: Technology and Applications, focal press, 2003.

OBJECT ORIENTED PROGRAMMING USING C++ :

Introduction: Overview of C++, sample C++ program, different data types, operators, expressions, and statements, arrays and strings, pointers & user-defined types function components, argument passing, inline functions, function overloading, recursive functions. (6 hours)

Classes & Objects: Class specification, class objects, scope resolution operator, access members, defining member functions, data hiding, constructors, destructors, parameterized constructors, static data members, functions, friend functions, passing objects as arguments, returning objects, arrays of objects, dynamic objects, pointers to objects, copy constructors, applications of operator overloading using friend functions. (8 hours)

Inheritance: Base class, inheritance and protected members, protected base class inheritance, inheriting multiple base classes, constructors, destructors and inheritance, passing parameters to base class constructors, granting access, virtual base classes. (8 hours)

Virtual functions, polymorphism: Virtual function, calling a virtual function through a base class reference, inheritance of virtual functions, hierarchical virtual functions, pure virtual functions, abstract classes, early and late binding. (4 hours)

I/O system basics, file I/O: C++ stream classes hierarchy, stream I/O, file streams and string streams, file operations, overloading I/O operators, error handling, formatted I/O. (6 hours)

Exception handling: Benefits of exception handling, throwing an exception, try block, catching an exception, exception specifications, stack unwinding, re-throwing an exception, catching all exceptions. (4 hours)

TEXT / REFERENCES:

- Herbert Schildt , "The Complete Reference C++", 4th Edition, Tata McGraw Hill, 2003.
- Robert Lafore, "Object-Oriented Programming in C++", 4th Edition, Pearson Education, Reprint 2011.
- Stanley B.Lippmann, Josee Lajore, "C++ Primer", 4th Edition, Pearson Education, 2005.
- Paul J Deitel, Harvey M Deitel, "C++ for Programmers", Pearson Education, 2009.
- K R Venugopal, Rajkumar Buyya, T Ravi Shankar, "Mastering C++", Tata McGraw Hill, 2011.

LINEAR ALGEBRA FOR SIGNAL PROCESSING:

Linear equations: System of linear equations and its solution sets, elementary row operations and echelon forms, matrix operations, invertible matrices, LU - factorization, determinant, rank. (7 hours)

Vector spaces: Vector spaces, subspaces, bases and dimension, coordinates, matrices as linear transformations, null space and column space, pseudo. Inverse and applications, projection operator. (8 hours)

Eigenvalues and Eigenvectors: Characteristic equation, diagonalization, Jordan canonical form, special matrices, positive definite matrices and applications. (7 hours)

Orthogonality and least squares: Inner product spaces, Schwarz's inequality and applications, Gram-Schmidt process, generalized Fourier series, QR factorization, least squares and their applications. (7 hours)

Symmetric matrices and quadratic forms: Diagonalization, quadratic forms, constrained optimization, singular value decomposition and related applications. (7 hours)

TEXT / REFERENCES:

- Gilbert Strang, "Linear Algebra and its Applications", 3rd edition, Thomson Learning Asia, 2003.
- David C. Lay, "Linear Algebra and its Applications", 3rd edition, Pearson Education (Asia) Pte. Ltd, 2005.
- Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd edition, PHI, 2004.
- Sohail A Dianat and Eli Saber, "Advanced Linear Algebra for Engineers with MATLAB", 1st Edition, CRC Press.

ELECTIVE – V

IEC/IEE 364 **3-0-0-3**

OPTICAL FIBER COMMUNICATION:

Planar dielectric waveguides: Derivation and solution of Eigenvalue equation for planar symmetric dielectric waveguides, TE and TM modes, birefringence in planar dielectric waveguides, power calculations. (6 hours)

Step and graded index fibers: Derivation and graphical solution of wave equation for step index fibers with emphasis on single mode fibers, concept of V-number and its significance, power calculations, birefringence in single mode fibers, Hi-Bi fibers, application of optical fibers in communication networks. (7 hours)

Distortion of optical pulses propagating through fibers: Intermodal and intra modal (chromatic/material and waveguide) dispersion, propagation of Gaussian optical pulses through dispersive fibers, dispersion compensation mechanisms. (6 hours)

Fiber amplifiers: Concept of optical amplification, erbium doped fiber amplifier (EDFA), SOA. (5 hours)

Advanced modulation and demodulation formats for optical fiber communications: Coherent detection of ASK, FSK and PSK. Optical DQPSK, DOPSK and QAM, optical CDMA. (6 hours)

Wave propagation through anisotropic media: Concept of permittivity tensor and index ellipsoid, linear electro-optic effect (Pockel's effect), bulk optic amplitude and intensity modulators, integrated optic amplitude and intensity modulators based on Mach-Zehnder interferometer. (6 hours)

TEXT / REFERENCES:

- G. Keiser, "Optical Fiber Communications", Tata McGraw Hill, New Delhi, 2010.
- M. Sathish Kumar, "Fundamentals of Optical Fiber Communication", Prentice Hall of India, New Delhi. Second Edition, 2014.
- A. Ghatak and K. Thyagarajan, "Introduction to Fiber Optics" Cambridge University Press, NY, 1998.
- A. Ghatak and K. Thygarajan, "Optical Electronics" Cambridge University Press, NY, 1989.
- H. Ganapathy Hebbar, "Optical Fiber Communication", Elsevier, 2013.

LIGHTING CONTROLS: TECHNOLOGY AND APPLICATIONS:

Lighting controls & Strategies: Lighting control system - Basic functions - Input/output devices - Introduction to lighting control strategies - Occupancy Sensor - Load scheduling, Dimming control – Energy management strategies. (3 hours)

Occupancy sensor, Load scheduling & Dimming control: Occupancy sensing techniques: PIR - Ultrasonic, PIR + Ultrasonic – Acoustic + PIR - Energy savings from sensing techniques - Switching and lamp life, Load scheduling control: Types – Lighting control panel – occupant override - Stand-alone v/s Interconnected panels - Centralized & Localized control - Control Zones and Energy Codes - Single-line riser diagram, Dimming control : Types of dimming – Dimming control for light sources. (8 hours)

Lighting control system design: Programming the project - Energy Management and Sustainability - Basis of design (Conceptual design) - Written controls narrative and its benefit - Zones, Design development – Placing the controller and equipment specification. (4 hours)

Commissioning and energy codes: Benefits of commissioning – Commissioning process as per standards - Performance testing – Equipment verification - Commissioning & LEED - Energy codes (ASHRAE/IESNA & IECC). (3 hours)

Daylight harvesting: Introduction – Daylight v/s Sunlight – Constraints - Daylight harvesting and LEED - Light Control Impacts these LEED Categories and Credits – Energy saving

Control techniques – Daylight harvesting systems – Control zones – Granular zoning – photosensors - Spatial response, Dead band - Wireless sensors – Centralized and distributed control. (3 hours)
Control signals & Protocols: Introduction - Analog control – Digital control - Standard protocols for lighting control : DMX controller - DALI – ZigBee - ZigBee network applications - Wireless RF lighting control - Benefits of lighting control – Basic system - Features of IEEE 802.11 - Integration with hardwired controls. (9 hours)
Energy management and building control system: Principles – Impact of lighting control on HVAC – Power quality issues – Integrated versus separate lighting control. (2 hours)
Applications of lighting control system Design patterns to different applications: Auditoriums - Class rooms - Conference rooms - File/storage system - Laboratories – library Reading areas - Open & private offices. (4 hours)

TEXT / REFERENCES:

- Robert S Simpson, Lighting Controls: Technology and Applications, focal press, 2003.
- IES lighting Handbook, 10th Edition IESNA-2-11.
- Craig DiLouie , Advanced lighting control: Energy saving productivity, Technology and Applications, Fairmont Press, Inc, 2004
- Extracts from current literature.

SOFT COMPUTING:

Fundamentals: Fundamentals of Artificial Neural Networks, McCulloch – Pitts model, Activation functions, Feed forward and feedback networks, learning rules – Hebbian, Perceptron, delta, Widrow-Hoff, winner take all. (8 hours)
Single-layer feed forward networks: Classifiers, Decision regions, Discriminant functions, minimum distance classification. (2 hours)
Multi-layer feed forward networks: Linearly non-separable pattern classification, generalized delta learning rule, error back propagation training algorithms. (6 hours)
Single layer feedback network: Hopfield network, associative memories, energy function, Bi-directional associative memory. (4 hours)
Application: Application of neural networks: Control applications, A-D conversion, Character recognition. (6 hours)
Fuzzy logic: Introduction, membership function, classical sets & fuzzy sets, fuzzy set operations, Fuzzy relations, extension principles. Linguistic variables, Fuzzy IF_THEN statements, Inference rules, Defuzzification methods. (6 hours)
Application: Application of fuzzy logic to control systems using fuzzy logic tool box. Introduction to fuzzy-neural systems. (6 hours)
Genetic Algorithms: Introduction, fitness function, cross-over, mutation, application to simple problems. (2 hours)

TEXT / REFERENCES:

- J. S. T Jang, C.T Sun and E. Mitzutani "Neuro-Fuzzy and Soft Computing", Prentice Hall International, Inc, 1997.
- Chin-Teng Lin, C.S.George Lee, "Neural Fuzzy Systems", Prentice – Hall International, Inc.1996.
- Jose C, Principe, Neil R. Euliano and W. Curt Lefebvre, "Neural and adaptive systems", John Wiley & Sons, Inc, 2000.
- John Yen and Reza Langari, "Fuzzy logic intelligence, control, and information", Pearson Education, Inc, 2004.
- Shehu S Farinwata, Dimitar Filev and Reza Langari, "Fuzzy Control: Synthesis and Analysis", John Wiley & Sons, Ltd., 2000.

- S. Haykin, "Neural Networks - A Comprehensive Foundation - 2nd Edition", Prentice Hall, 1999.
- Kasuo Tanaka, An Introduction to Fuzzy Logic for Practical Applications, Springer, 1997
- T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, Inc., 1995

EMBEDDED SYSTEM DESIGN:

Introduction: Embedded systems overview (definition, salient characteristics, examples), optimizing design metrics, processor technology, IC technology, design technology, trade off. (2 hours)

Processors, Hardware & Software: Custom single purpose processors – combinational logic, sequential logic, custom single purpose processor design, optimizing the design. General purpose processors – Basic architecture, operation, programmers view, and general purpose processor design. (8 hours)

Typical embedded system: Core of the embedded system, memory, sensors & actuators, communication interface, embedded firmware and other system components. (7 hours)

Hardware and software co-design: Fundamental issues, computational models, techniques used to integrate hardware and software, design flow and development tools. (3 hours)

Operating systems: Basics, types of OS, tasks, process & threads, multiprocessing and multitasking, concurrent processes, communication among processes (shared memory and message passing), synchronization among processes, implementation, simple problems on scheduling algorithms. (7 hours)

Embedded C programming: Embedded C programming concepts, programming 8051 controller using embedded C. (7 hours)

Embedded development life cycle (EDLC): Objectives and phases of EDLC, case studies. (2 hours)

TEXT / REFERENCES:

- Frank Vahid & Tony Givargis, “Embedded system design”, Wiley Publication, 2002.
- Shibu K. V, “Introduction to embedded systems” , Mc Graw Hill Publication, 2013.
- K.J. Ayala, Dhananjay V. Gadre “The 8051 Microcontroller and Embedded systems”, Cengage Learning, 2010.
- Raj Kamal, “Embedded Systems”, 2nd edition, Tata McGraw Hill.

ELECTIVE – VI

IEC/IEE 365 3-0-0-3

CIPHER SYSTEM:

Introduction: Security goals, cryptographic attacks, services and mechanism, techniques. (2 hours)

Number theory: Time estimation, divisibility, Euclidian algorithm, divisibility, congruence, Chinese remainder theorem, Euler function, modular exponentiation. (4 hours)

Basic cryptographic techniques: Shift, linear and affine transformation, enciphering matrices (Hill cipher), Vigenere and Beufort cipher systems. (6 hours)

Introduction to modern symmetric key cipher: Modern block cipher, stream cipher, Fiestel cipher, simplified DES, DES, block cipher influenced by DES, RC.5, Blowfish algorithm. (2 hours)

Advanced encryption standard: Algebraic structure, Galois field, AES encryption and decryption algorithm, block cipher modes. (6 hours)
Asymmetric key cipher: Knapsack problem, Merkle - Hellman, RSA, Rabin, Elgamal and elliptic curve cryptography. (6 hours)
Message integrity and message authentication: MD hash function, SHA.512, Whirlpool algorithms, digital signatures and authentication protocols. (6 hours)

TEXT / REFERENCES:

- Neal Koblitz, "A course in Number Theory and Cryptography", 2nd Edition, Springer.
- Behrouz A. Forouzan, D. Mukhopadhyay, "Cryptography and Network Security", 2nd edition, Tata Mc Graw Hill.
- William Stallings, "Cryptography and Network Security", 4th edition, Pearson Education.
- Henry Beker, Fred Piper, "Cipher systems: the protection of communications" Northwood Books, 1982.

ENERGY AUDITING AND MANAGEMENT:

Energy: Energy Types, Needs, Scenario, Security, Environmental Impact, Costs, Material & Energy Balance, Consumption Pattern, Sankey Diagram, Energy Policy, Information Systems, Energy Conservation Act 2001, Electricity Act 2003, Energy Reforms, National Action Plan for Climate Change (NAPCC), Standards & Labels. (10 hours)

Energy Audit: Purpose, Scope, Types, Methodologies, Reporting, Instruments, Energy Auditor Responsibilities, Case Studies. (3 hours)

Energy Management: Energy Management principles, Strategy, Benchmarking, Energy Manager Responsibilities, Case Studies. (7 hours)

Performance Assessment: Boilers, Steam Systems, Furnaces, Insulation, Cogeneration, Waste Heat Recovery, Transformers, Motors, Compressors, Fans & Blowers, Pumps, Illumination Systems, DG Sets. (10 hours)

Energy Economics : Economic analysis of investments, Simple payback method, return on investment, net present value, internal rate of return, life cycle costing, energy performance contracts and role of ESCOs. (6 hours)

TEXT / REFERENCES:

- Paul W. O'Callaghan, "Energy Management – A comprehensive guide to reducing costs by efficient energy use", McGraw Hill, England, 1992
- IEEE Std. 739-1995, "IEEE recommended practice for energy management in industrial and commercial facilities".
- Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2000
- W.R. Murphy and G. McKay, "Energy management", Butterworth & Co Publishers, Oxford, UK, 2001.
- BEE Study Material, Energy Management & Energy Audit, www.bee-india.com

DATA STRUCTURES AND ALGORITHMS:

Data Structures: Arrays; linked lists; trees; stacks; queues; graphs, data structure operations
Analysis of Algorithms: Introduction, Time-space trade off, Complexity, control structures - sequential; selection; iteration, Rate of growth, Big-O notation. Arrays: Introduction, linear arrays, inserting, deleting, sorting, linear search, binary search, pointers, pointer arrays. (4 hours)
Linked Lists: Introduction, representation of linked lists in memory, traversing a linked list, searching a linked list, memory allocation, garbage collection, Insertion into a linked list, deletion from a linked list, doubly linked list. (4 hours)
Stacks: Introduction, array representation of stacks, arithmetic expressions, Polish notation, Quicksort, recursion, Tower of Hanoi Queues: Introduction, representation, priority queues, Circular queues, double ended queue. (5 hours)
Trees: Introduction, binary trees, representing binary trees in memory, Traversing binary trees, traversal algorithm using stacks, Header nodes, threads, binary search trees, searching and inserting in binary search trees, deleting in a binary search tree, Heap, heapsort, Huffman's Algorithm Graphs: Introduction, graph theory terminology, sequential representation of graphs, Warshall's algorithm, linked representation of graphs, Operations on graphs, traversing a graph, Topological sorting. (9 hours)
Sorting: Introduction, insertion sort, Selection sort, merging, merge sort, radix sort
Searching: Introduction, searching and data modification, linear search, binary search, Hashing - Hash Tables, Hash functions, Open addressing. (5 hours)
Greedy Algorithms: Prim's & Kruskal's algorithms for minimum spanning trees, shortest paths, optimal tape storage, job scheduling with deadlines, Knapsack problem, Huffman Code
Divide & Conquer: General technique, maximum and minimum, Multiplying long integers, Strassen's matrix multiplication, finding the closest pair of points. Dynamic Programming: Matrix chain ordering, all pairs shortest paths, Optimal BST. (9 hours)

TEXT / REFERENCES:

- Ellis Horowitz, Sartaj Sahni, Dinesh Mehta, "Fundamentals of Data Structures in C++", Galgotia Publications, Reprint, 2004.
- Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", 2nd Edition, Pearson Education, 2005.
- Lipschutz, "Data Structures with C++", Schaum outline series, 2006.
- Michael T. Goodrich, Roberto Tamassia, David Mount, "Data Structures and Algorithms in C++", John Wiley & Sons, 2011.

COMPUTER ORGANIZATION AND ARCHITECTURE:

Introduction: Overview of architecture of typical computers, accumulator based, and general register machines and stack machines. Instruction set, instruction formats, types and addressing modes, reverse polish notation, op-code encoding techniques. (8 hours)
ALU design: Review of number system, basic ALU organization, and general register design. Combinational shifter design. Adders, CLA, CSA, multiplier design, high speed multiplier design. Booth's and modified Booth's algorithm, Wallace tree structure, arithmetic processors. IEEE floating point representation. (7 hours)
Memory organization: Memory hierarchies, main memory and cache memory, memory management techniques, cache mapping functions - associative and direct. Introduction to virtual memory, cache coherence protocols (6 hours)

Input/output organization: Isolated I/O, memory mapped I/O, programmed I/O, interrupt driven I/O, DMA, data transfer methods and bus arbitration. (3 hours)

Control unit: Instruction processing and control unit, instruction cycle and processor concepts, single bus processor, multiple bus processor, hardwired control unit, micro programmed control unit. (6 hours)

Advanced concepts: Pipelining and parallel processing, instruction pipelining and pipeline hazards. RISC architecture in modern processors, performance enhancement strategies, concept of superscalar architecture, VLIW architecture, vector computing and array processing, multiprocessor systems and servers. (6 hours)

TEXT / REFERENCES:

- B. Govindarajulu, "Computer Architecture and organization. Design principles and Applications", 2nd edition, McGraw Hill, 2005.
- M. Raffiquzzaman & Raja Chandra, "Modern Computer Architecture", Galgotia publications, New Delhi, 1990.
- M Morris Mano, "Computer system architecture", 3rd edition, Pearson Education, Delhi, 2002.
- Nicholas Carter, "Computer architecture", Schaum's outlines, McGraw.Hill, New Delhi, 2006.
- V. Carl Hamacher, Z. Vranesic & S. Zaky "Computer Organization", 5th edition, McGraw Hill International Edition, Computer Science series,1998.
- David A. Patterson & John L. Hennessy, "Computer Organization and Design. The Hardware/Software Interface", 3rd Edition, Elsevier, 2005.

SEMINAR

IEC / IEE 366 **0-0-3-1**

Students need to present a seminar on a topic of recent developments in their subject filed.

B.Sc. (MECHANICAL)

II SEMESTER

IMA 121 – MATHEMATICS - II (Refer page no.**33**)
IPH 121 – PHYSICS - II (Refer page no.**33**)
ICH 121 - CHEMISTRY (Refer page no. **35**)
IME 121 – ENGINEERING GRAPHICS - II (Refer page no.**36**)

BASIC MECHANICAL ENGINEERING

IME 122 **3-1-0-4**

Properties of Steam and Boilers: Steam formation, Types of steam, Steam properties- Enthalpy, Simple numericals for finding enthalpy and dryness fraction. (5 hours)
Steam Boilers: Classification, Working principle of Babcock & Wilcox Boiler, Lancashire, locomotive boiler, boiler mountings, accessories (4 hours)
Prime Movers: Classification of Prime movers, Working principle of steam, gas and water turbines, Concept of impulse and reaction steam turbines, compounding. (5 hours)
Power plants: Introduction, Working principle of thermal, nuclear, hydel and solar power plants. (4 hours)
Refrigeration: Principle and working of vapour compression refrigeration system, Desirable properties of an ideal refrigerant, Definition of COP, Unit of refrigeration. (2 hours)
I.C. Engines: Classification, Working of 2-stroke, 4- stroke C.I and S.I Engines with P-V diagrams, Definitions and simple numericals for determining Indicated Power, Brake Power, Mechanical efficiency, Indicated thermal efficiency, and Brake thermal efficiency, Working of simple carburetor, Types and properties of lubricants, Splash lubrication system. (8 hours)
Power Transmission: Definition, Belt drives- open and crossed ,Velocity ratio, Stepped cone pulley, Fast and loose pulley, Length of belt, Tension in the belt, Slip, Creep (No derivations), Introduction to rope drive and chain drives, Gear Drives-Types of gears, Velocity ratio for Gear trains, Simple and compound gear trains, Numericals on belt and gear drives. (8 hours)

Machine Tools: Lathe -Classification, Block diagram of engine lathe, Specification of lathe, List of lathe operations. Drilling- Classification of drilling machines, Block diagram of radial drilling machine, List of drilling operations. (5 hours)

Casting and Forging: Types of moulding sand and its desirable properties, Patterns- Single piece and split piece pattern, Pattern allowances, Steps in the preparation of two box green sand mould, Defects in casting, Introduction to forging. (3 hours)

Welding: Classification, Principle of Resistance spot welding, Electric arc welding and oxy-acetylene gas welding, Gas flames, Introduction to soldering and brazing. (2 hours)

Introduction to Engineering Materials: Ferrous and Non-ferrous metals and its properties, Introduction to heat treatment. (2 hours)

TEXT/ REFERENCES:

- K. R. Gopalakrishna, "Text book of elements of Mechanical Engineering", Subhash Publications, Bangalore, 2005.
- Roy & Choudhury, "Elements of Mechanical Engineering", Media Promoters & Publishers Pvt. Ltd, Mumbai, 2000.
- Mishra B.K., "Mechanical Engineering Sciences", Kumar & Kumar Publishers Pvt. Ltd., Bangalore, 1999.
- Trymbaka Murthy S., "A text book of elements of Mechanical Engineering", I. K. International Publishing House Pvt. Ltd, 2010.
- Rajput R. K., "Elements of Mechanical Engineering", Fire Wall Media, 2005.
- B. S. Raghuwanshi, "A Course in Workshop Technology", Vol 1, Dhanpat Rai & Sons, New Delhi, 2005.

STRENGTH OF MATERIALS

IME 123 **3-1-0-4**

Stress, Strain and Deformation of Solids: Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads. (10 hours)

Beams - Loads and Stresses:Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams – Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section – Effect of shape of beam section on stress induced – Shear stresses in beams – Shear flow. (10 hours)

Torsion:Analysis of torsion of circular bars – Shear stress distribution – Bars of Solid and hollow circular section – Stepped shaft – Twist and torsion stiffness – Compound shafts – Fixed and simply supported shafts. (8 hours)

Beam deflection: Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope : Double integration method, Macaulay Method, and Moment-area Method –Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns. (10 hours)

Analysis of stresses in two dimensions: Biaxial state of stresses – Thick & Thin cylindrical shells and spherical shells – Deformation in thick & thin cylindrical and spherical shells – Biaxial stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress - Strain energy in bending and torsion. (10 hours)

TEXT/ REFERENCES:

- Beer F. P. and Johnston R (2002) "Mechanics of Materials", McGraw-Hill Book Co, Third Edition.
- Nash W.A (1995) "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co, New York
- Ryder G.H (2002) "Strength of Materials", Macmillan India Ltd., Third Edition
- Ray Hulse, Keith Sherwin & Jack Cain (2004) "Solid Mechanics", Palgrave ANE Books
- Singh D.K (2002) "Mechanics of Solids" Pearson Education

- Timoshenko S (1997) "Elements of Strength of Materials", Tata McGraw-Hill, New Delhi

III SEMESTER

IMA 231 – MATHEMATICS - III (Refer page no.**39**)

THERMAL ENGINEERING

IME 231 **3– 1– 0 – 4**

Basic concepts: Macroscopic and Microscopic approach, Basic definitions-thermodynamic system, state, process, cycle, intensive and extensive properties, thermodynamic equilibrium, quasi-static process, irreversible process, Zeroth Law, path and point function. (3 hours)
Work and heat transfer: Thermodynamic definition of work, Displacement work (pdv work), pdv work for various processes, Heat transfer- a path function. (3 hours)

First law of thermodynamics : First Law for a non-flow system undergoing a cyclic and non-cyclic process, numericals, Energy- a property of a system, PMM1, Steady flow energy Equation (SFEE) for simple devices-numericals. (6 hours)

Second law of thermodynamics and Entropy: Need for second law, cyclic heat engines, reversed heat engines, Kelvin-Planck and Clausius statements, PMM2, Carnot cycle, Carnot theorem, concept of entropy, Clausius inequality, entropy change non-flow processes, numericals. (8 hours)
Power cycles: Vapor power cycle: Simple Rankine cycle, effect of boiler pressure, on Rankine cycle, Reheat Rankine cycle, Mollier chart- simple numericals. Gas power cycles: Air standard cycle-Otto, Diesel cycle, Air standard efficiency-numericals. (10 hours)

Reciprocating air compressors: Single stage- work of compression, Effect of clearance, Volumetric efficiency, need for multi-stage compression, intercooling, minimum work of compression- simple numericals. (5 hours)

Refrigeration: Principles of refrigeration, Properties of refrigerants, Air refrigeration - numericals, Vapour compression and Vapour absorption types, Coefficient of performance. (4 hours)
Elements of heat transfer: Conduction in plane, cylindrical and composite wall, electrical network analogy, Conduction with convective boundary, Numericals, Convection heat transfer-definition, mechanism, Nusselt number, Fundamentals of radiation heat transfer, Black body concept, Grey body, emissivity, Kirchoff's law, Stephen- Boltzmann law. (6 hours)
Performance testing of IC engines: Measurement of BP, IP, FP, various efficiencies, heat balance sheet and performance characteristics. Numericals. (3 hours)

TEXT / REFERENCES:

- Cenegel Yunus and Bole Michael, Thermodynamics: An Engineering Approach, McGraw Hill, New York, 2010.
- Estop and McConkey, Applied Thermodynamics for Engineering Technologies, Pearson Education, Delhi, 2002.

- Mayhew A. and Rogers B., Engineering Thermodynamics, E.L.B.S. Longman, London, 1994.
- Van Wylen and G. J. and Sonntag R. E., Fundamentals of Classical Thermodynamics, John Wiley, New York, 1985.
- Cengel, Thermodynamics and Heat Transfer, McGraw Hills, New York, 1997.

MANUFACTURING PROCESS ENGINEERING

IME 232 **4– 0– 0 – 4**

Foundry: Moulding, Types of moulding, Moulding materials, Moulding sand, Composition of moulding sand. Sand Testing - Permeability test, Strength test, Moisture content test, Clay content test, Grain fineness test. (5 hours)

Casting: Types of casting- Investment casting, Permanent mould casting, Slush casting, Pressure die casting (Hot chamber & Cold chamber), Centrifugal casting and Continuous casting, Advantages & limitations of casting process. (5 hours)

Welding: Classification of welding processes, Metal arc welding, Consumable and non-consumable arc welding process, Submerged arc welding, Atomic-hydrogen welding, TIG, MIG, Electro-slag, Resistance welding - Spot, Seam, Projection. Special type of welding - Thermite welding, Friction welding, Explosive welding, Electron beam welding, Laser beam welding, Advantages, limitations and applications of welding. (6 hours)

Mechanical working of metals: Cold, Warm, Hot working. Sheet metal forming- Shearing, Shearing operations – Punching, Blanking, Embossing, Coining, Lancing, Slitting, Bending, Bulging, Curling and Roll forming. (4 hours)
Theory of metal cutting: Orthogonal and oblique cutting, Cutting parameters like cutting speed, feed, depth of cut and their selection criteria, Machinability parameters, Tool life and wear. Merchant's analysis, Taylor's equation, Factors affecting tool life. Simple problems on shear plane angle, Cutting force and tool life calculation. (5 hours)

Lathe: Constructional features, Classification of lathe, Accessories and attachments of lathe, Back gear arrangement, Lathe operations, Speed, feed and depth of cut. Calculations of machining time. (5 hours)

Drilling: Classification, Construction and specification of Radial drilling machine, Types of drill bits, Elements of a twist drill, Computation of drilling time. (3 hours)

Milling: Types of milling machines, Column and Knee type milling machine, Attachments, Milling operations, Plain milling cutters, Simple and compound indexing, Machining time calculations. (5 hours)
Shaping and Planing: Shaper- Working principle & operations. Planer - Comparison between shaper and planer, Double housing planer, Operations. (3 hours)

Grinding: Grinding wheel – Abrasive particles, Bonding materials, Designation and selection, Dressing and truing. Classification of grinding machines, Constructional features and principles of cylindrical, surface and centreless grinding machines. (4 hours)

Rapid prototyping: Basic process, Working principle of Fused deposition modeling, Stereo lithography, Selective laser sintering, Applications, advantages and limitations of rapid prototyping. (3 hours)

TEXT / REFERENCES:

- Chua C K, Leong K F and Lim C S, Rapid Prototyping: Principles and Applications, World Scientific, Singapore, 2003.
- Paul DeGarmo E, Black J T and Ronald A. Kohser, Materials and Process in Manufacturing, John Wiley & Sons, Delhi, 2004.
- Rajput R. K., A Text book of Manufacturing Technology, Laxmi Publications Private Limited, 2011.
- Khanna O. P., A text book of Production Technology, Dhanpat Rai Publications.
- Rao P. N., Manufacturing Technology, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
- Serope Kalpakejian and Steven R Schmid, Manufacturing Engineering and Technology, Pearson Education, Delhi, 2006.
- Lal M. and Khanna O. P., Foundry Technology, Dhanpat Rai and Sons, New Delhi, 1991.

MATERIAL SCIENCE AND METALLURGY

IME 233 **3– 0– 0 – 3**

Introduction: Need, purpose and importance of the subject, Crystal structures (Cubic and HCP structures), Computation of packing factor of cubic and HCP structure, Co-ordination number, Miller indices, Crystal imperfections-point & Line defects. (5 hours)

Solidification: Meaning, Degree of super cooling, Homogeneous and Heterogeneous nucleation, Mechanism of solidification – Nucleation and Crystal growth, Dendritic growth. (3 hours)

Phases in solids: Phases-Single phase and multiphase, Gibb's phase rule, Solid solutions and Types, Intermediate phases, Equilibrium diagrams(only binary) – Construction and Explanation of Isomorphous and Eutectic systems, Equilibrium and Non-equilibrium cooling, Invariant reactions (Euctectic, Peritectic and Eutectoid), Lever rule and its application on Isomorphous and Eutectic systems, Equilibrium and Non-equilibrium cooling of an alloy and congruent melting alloy phase. (9 hours)

Iron-Carbon systems: Introduction- allotropy and Polymorphism, Cooling curve for pure iron, Fe-C equilibrium diagrams, Study of iron-carbon system in detail with emphasis on the invariant reactions. (6 hours)

Heat treatment: Principle and Objectives of heat treatments, Isothermal transformation diagram- Construction and Explanation, Factors affecting shape and Position of isothermal transformation diagram, Continuous cooling curves on isothermal transformation diagram, Processes like annealing, Normalizing, Hardening, Tempering and Case hardening with heat treatment cycle, Jominy hardness test. (9 hours)

Ferrous-alloys: Composition, Properties and Applications of alloy steels (plain carbon steels, stainless steels, free machining steels, HSS and Maraging steels, Cast irons-grey, White and Malleable cast irons. Non-ferrous alloys - Types and Explanation of brasses, Bronzes and Al-Cu alloys. (4 hours)

TEXT / REFERENCES:

- Avner S.H., Introduction to Physical Metallurgy, (3e), McGraw Hill, 2004.
- William D. Callister, Materials Science and Engineering, John Wiley & Sons, 2007.
- Lakhtin Yu., Engineering physical metallurgy and heat treatment, MIR Publishers, 1985.
- Gupta K.M., Material science, Metallurgy and Engineering Materials, Umesh Publication, 2012.
- Raghavan V, Material Science and Engineering, (4e), Prentice Hall of India, 1989.
- Arzamasov, Material Science, MIR Publishers, Moscow, 1989.
- Clark Donald S., Physical metallurgy for engineers, 1962

FLUID MECHANICS

IME 234 **3– 0– 0 – 3**

Properties of fluids: Mass density, specific weight, relative density, specific volume, coefficient of dynamic viscosity, kinematic viscosity, Newtonian and Non-Newtonian fluids, ideal and real fluids, surface tension, capillarity, vapor pressure, bulk modulus and compressibility. (4 hours)

Fluid statics: Intensity of pressure, Pascal's law, pressure variation in static fluid, pressure measurement by manometers. (4 hours)

Hydrostatic forces on surfaces: Resultant hydrostatic force and centre of pressure on horizontal, vertical, inclined and curved plane surface submerged in a liquid. (4 hours)

Buoyancy: Equilibrium of floating bodies, Metacenter and Metacentric height, determination of metacentric height (Experimental and Analytical). Stability of floating and submerged bodies. (4 hours)

Kinematics of fluid flow: Methods of describing the fluid motion, path line, stream line, streak line and stream tube. Types of flow, Continuity equation for one and three dimensional flow, fluid velocity and acceleration. (4 hours)

Dynamics of fluid flow: Energy possessed by fluid, Euler's equation of motion along a stream line and reducing it to Bernoulli's equation, Impulse momentum equation. (4 hours)

Dimensional analysis: Fundamental and derived units of dimensions, dimensional homogeneity, Rayleigh's method and Buckingham's Pi-theorem, similitude, types of similarity, significance of dimensionless numbers. (4 hours)

Fluid flow measurements: Venturimeter, Orifice, Orifice meter, Pitot tube and V-notch and Rectangular notch. (4 hours)

Viscous Flow: Reynolds experiment, Reynolds Number, critical Reynolds number laminar flow through circular pipe (Hagen Poiseuille's equation), laminar flow between fixed parallel plates. (4 hours)

Flow through pipes: Major loss and Minor losses in pipe flow, Darcy and Chezy equation, Siphon, Hydraulic gradient and Total energy line. (4 hours)

TEXT / REFERENCES:

- Streeter V. L. and Beinzamin E., Fluid Mechanics, Willy Intl., New York,1998.
- Bruce R. Munson, Donald F. Young and Teodore H. Okiishi, Fundamentals of Fluid Mechanics, Wiley, 2005.
- Modi P. N. and Seth S. M., Hydraulics and Fluid Mechnics, Standard Book House, 2011.
- Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House, New Delhi, 2000.

- Bansal R. K., Fluid Mechanics and Hydraulic Machines, Laxmi Publication, New Delhi, 2006.
- Yunus A. Cengel and John M. Cimbla, Fluid Mechanics, Tata McGraw-Hill Publications, 2006.

AUTOMOBILE ENGINEERING

IME 235 **3– 0– 0 – 3**

Automotive engine parts: Automotive engine classification, Multi cylinder arrangements. Cylinder block, Cylinder head, Crankcase, Oil pan, Cylinder liners, Piston, Arrangements to control piston slap, Piston rings, Connecting rod, Crank shaft, Valves and valve operating mechanisms, Valve timing diagram. (6 hours)

Fuel supply system: Fuel pumps for petrol and diesel engines, Mixture strength requirements for SI engine, Defects of a simple carburetor and their remedies, Types of carburetors, Constant choke and constant vacuum carburetors. Fuel injector and Multi Point Fuel Injection system. (3 hours)

Ignition, Cooling and Lubrication systems: Battery ignition system, ignition advance methods, Comparison between battery and magnetic ignition system, starting system – Bendix drive, Generator. Methods of engine cooling, Air cooling, Water cooling, Thermosyphon cooling, Forced cooling, Thermostatic cooling. Objectives of Lubrication, Types of lubrication systems, Splash lubrication, Full pressure lubrication, Semi-Pressure lubrication, Crankcase ventilation. (3 hours)

Clutch and Gear box: Clutches- Purpose and requirements, Single plate clutch, Multi-plate clutch, Centrifugal and semi centrifugal disc clutch, Fluid flywheel. Gear box - Purpose, Constant mesh gear box, Synchromesh gear box, Epicyclic (Automatic) gear box and torque converter. Overdrive mechanism, Calculation for torque transmitted by single plate clutch and multi-plate clutch, Power for propulsion of the vehicles, Road resistance and tractive effort, Relation between vehicle speed and gear ratio. (7 hours)

Drive to wheels and Tyres: Torque reaction, Driving thrust, Braking torque, Hotchkiss drive, Torque tube drive, Universal joint, Constant Velocity joint, Propeller shaft, Differential gear box, Types of rear axle. Tyres - Desirable tyre properties, tube and tubeless tyres. (5 hours)

Steering system: Steering geometry, Camber, Castor, Toe-In and Toe-Out, Steering mechanism: Davis and Ackerman steering gear mechanism, Steering linkages for rigid axle and independent suspension systems. Numerical problems related to conditions for pure rolling, Turning circle radius, Centre point steering and semi centre point steering. (6 hours)

Suspension system: Requirements of a good suspension systems, Effect of pitching, rolling and yawing, Types of suspension: Leaf springs, Coil spring, Rubber springs and Torsion bar. Independent front and rear suspension, Telescopic shock absorber. (3 hours)

Brakes: Braking requirements, Brake efficiency and stopping distance, Fading of brakes, Types of brakes: Drum and Disc brakes, Mechanical brakes, Hydraulic brakes, Servo brakes, Air brakes, Balance beam compensator, Antilock braking system, Numerical related to brake torque and minimum stopping distance with front Wheel, rear wheel and four wheel braking, Weight transfer and heat dissipation. (3 hours)

TEXT / REFERENCES:

- Heinz Heisler, Vehicle and Engine Technology (2e), Butterworth-Heinemann Publication, Second Edition, 1998.
- Kirpal Singh, Automobile Engineering Vol. I & II (12e), Standard Publishers Distributors, New Delhi, 2011.
- R.K. Rajput, Automobile Engineering (1e), LaxmiPublication (P) Ltd, 2010.
- Narang G. B. S., Automobile Engineering, Khanna Publishers, 1990.
- Giri N. K., Automotive Technology, Khanna Publication, 2006.
- Gupta K. M., Automotive Technology Vol. I & II, Umesh Publication, 2007.

COMPUTER AIDED MECHANICAL DRAWING

IME 236 **0– 0– 6 – 2**

AutoCAD 2D drafting: Intersection of solids - prisms, cylinders, pyramids and cones. Threaded fasteners - thread forms, hexagonal, square bolts & nuts, foundation bolt. Bearings - Bush bearing, Footstep bearing, Plummer block. Couplings - Muff, Flanged, Oldham's and Universal. Joints - Knuckle, Socket & Spigot, Sleeve & Cotter, Strap joints with jib & cotter.

3D part modeling, assembly and sectional/exploded views using AutoCAD 3D: Vertical stuffing box, Simple eccentric, Drill jig, Square tool post, Non-return valve, Screw jack, Swivel bearing, Strap type connecting rod end, Machine vice.

Mini project: Projects on drafting, part modeling, assembly and sectional/exploded views in mechanical engineering applications.

TEXT / REFERENCES:

- Gopalkrishna K. R., Machine Drawing, Subhas Publications, Bangalore, 2002.
- Bhat N. D., Machine Drawing, Charotar Publishing House, Anands, 2002.
- Venugopal K., Engineering Drawing and Graphics + Auto CAD, Newage International Publishers, Delhi, 2002.
- Narayana K. L. and Kannaiah P, Text book on Engineering Drawing, Scitech Publications, Chennai, 2002.
- Ibrahim K Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill, New Delhi, 1998.

STRENGTH OF MATERIALS LAB [0 0 3 1]

IME 237 **0– 0– 3– 1**

List of Experiments:

1. Tension test on mild steel
2. Compression test on cast iron
3. Hardness tests - Rockwell, Brinell, Vicker's
4. Charpy impact test
5. Izod test on mild steel
6. Shear test on mild steel
7. Torsion test on mild steel
8. Fatigue test on mild steel
9. Test on leaf and helical spring
10. Bending and Compression test on wood

11. Microstructure study of metals
12. Heat treatment of steel

TEXT / REFERENCES:

- Suryanarayana A.V.K., Testing of Metallic Materials, PHI, 1990.
- Khanna and Justo, Highway Materials Testing, Nemchand, 1989.
- Technical Teacher's Training Institute, Laboratory Manual of Strength of Materials, Oxford University Press, 1983.
- Davis H.E., Troxell G.E., Wiscocil C.T., The Testing and Inspection of Engineering Materials, McGraw Hill Book Company.

IV SEMESTER

IHS 241 – ENGINEERING ECONOMICS & MANAGEMENT

(Refer page no.**45**)

THEORY OF MACHINES

IME 241 **3- 1 -0 –4**

Basic concepts: Mechanism and machine, Kinematic pair, link, chain and inversions, constrained and unconstrained motion, four bar mechanism, single and double slider crank mechanisms with inversions, quick return mechanism, toggle mechanism, Oldham Coupling, Hooke's coupling. (9 hours)

Velocity and Acceleration: Velocity - Relative velocity of coincident points on separate links, Determination of velocity in mechanisms by relative velocity method. Instantaneous Centres - Definitions, Three-centres-in-line theorem and its application to locate number of instantaneous centres, determination of velocity by instantaneous centre method. Acceleration - Determination of acceleration in mechanism by relative acceleration method. (9 hours)

Cams and Balancing: Types of Cams, types of followers, Cam profiles, graphical methods for simple harmonic motion and uniform acceleration and retardation, radial and oscillating followers. Balancing of rotating masses in single plane and different planes (Graphical Method). (10 hours)

Toothed gearing: Law of gearing, Spur Gears - Definitions, Terminology, cycloidal and involute teeth, path of contact, arc of contact, minimum number of teeth on the pinion to avoid interference, Terminology of helical and bevel gears. (8 hours)

Gear trains: Simple, Compound, Reverted and Epicyclic gear trains. (Tabular method). Torque calculations, Automobile differential mechanism. (5 hours)

Belts and rope drives: length of belts, effect of Slip and belt thickness, velocity ratio, ratio of tensions, power transmitted, centrifugal tension and its effect on power transmitted, condition for maximum power transmission by a flat belt. (4 hours)

Vibrations: Definitions, Types- longitudinal, transverse, torsional. Displacement, velocity and acceleration. Undamped free vibration of spring-mass system. (3 hours)

TEXT / REFERENCES:

- Ballaney P. L., Theory of Machines, Khanna Publishers, New Delhi, 1998.
- Rattan S. S, Theory of Machines, Tata Mc-Graw Hill Publishers Pvt. Ltd, New-Delhi, 2009.
- Singh, V. P., Theory of Machines, Khanna Publishers, New Delhi, 1998.
- Rao J. S. and Dukkipati R. V., Mechanism and Machine Theory, Wiley Eastern Ltd. Delhi, 1992.
- Gosh A., and Mallick A. K., Theory of Machines and Mechanisms, Affiliated East West Press, Delhi, 1989.
- Shigley, J. E. and Uicker J. J., Theory of Machines and Mechanisms, McGraw Hill, Delhi, 1980.

DESIGN OF MACHINE ELEMENTS

IME 242 **3- 1 -0 –4**

Introduction: Materials and their properties - Ductile and brittle fracture, Strain energy, Resilience, Toughness, Hardness, Creep, Hertz contact stresses, Material specification. Strength concepts - Principal stresses, Theories of failure, Factor of safety, Strength under combined axial, bending & torsional loads, Stress concentration. (7 hours)

Fatigue: S-N diagram, Low cycle and high cycle fatigue, Endurance limit, Variables affecting fatigue strength, Fluctuating stresses, Goodman & Soderberg equations, Modified Goodman diagram, Stresses due to combined loading. (5 hours)

Shafts and Keys: ASME code for design of transmission shafts, Mises Hencky theory for transmission shafting, Stress concentration, Design of shafts subjected to bending in two planes in addition to axial loads. Keys: Types of keys, Stress in keys, Design of square, rectangular, taper keys and splines. (10 hours)

Threaded fasteners: Stresses in bolts, Effect of initial tension, Bolts subjected to various eccentric loading conditions. (3 hours)

Power screws: Stresses in power screw, Efficiency of power screw, Force & torque requirement to lift load in power screw jack. (3 hours)

Springs: Types of springs, Helical coil springs (compression or extension springs of round/square/ rectangular wires). Spring materials, Stress & deflection of springs subjected to steady, Fluctuating & impact loads, Energy stored in springs, Critical frequency, Concentric springs. (6 hours)

Spur and Helical gears: Nomenclature, Stresses in gear teeth, involute gears, Lewis equation for beam strength of tooth, form factor & velocity factor. Design for static, dynamic and wear load. (8 hours)

Bearings: Construction, application, design, merits and demerits of journal bearings. Rolling Contact Bearing - types, capacity of bearings, bearing life, equivalent bearing load and bearing selection. (6 hours)

TEXT / REFERENCES:

- Hamrock B. J., Jacobson B.O. and Schmid S. R., “Fundamentals of Machine Elements”, Mc Graw Hill Inc., New York, 1999.
- Shigley J. E. and Mischke C. R., “Mechanical Engineering Design” , 5/e, McGraw Hill Inc, New York, 2004.
- Bhandari V. B., Design of Machine Elements, 2/e, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.
- Norton R. L., “Machine Design - An Integrated Approach”, 2/e, Prentice Hall Inc. New Jersy, 2004.

- Juvenile R. C. and Marshek K. M., "Fundamentals of Machine Component Design", 3/e, John Wiley and Sons, Inc, New York, 2000.
- Maleev and Hartman, "Machine Design" 5/e (Revised and edited by Drop Grover), CBS Publishers, New Delhi, 1999.
- Mahadevan K. and Balaveera Reddy K., "Machine Design Data Hand Book", 4/e, CBS Publishers and distributors' New Delhi, 1987.

INTERNAL COMBUSTION ENGINES

IME 243 **3- 0 -0 –3**

Introduction: Thermodynamics and Classification of IC engines, Idealized cycles and Processes: Otto, Diesel, Dual and Sterling Cycle. Comparison of Air-standard Cycle, Fuel air cycles and actual cycles. (4 hours)

Fundamentals of combustion: Introduction to combustion, modes of combustion, Stoichiometry, heat of formation, adiabatic flame temperature, chemical equilibrium. ignition limits, simple numericals. (4 hours)

Combustion in SI and CI engines: Combustion in SI engines: Stages of combustion, factors affecting the different stages of combustion, rate of pressure rise, Normal and abnormal combustion and Combustion Knock. Design and operational factors for control of knock. Combustion chamber design for SI engines. Combustion Phenomenon in CI engines: Stages of combustion, Delay period physical and chemical delay period, abnormal combustion in CI engines- Diesel Knock. Factors affecting delay period. Control of diesel knock. (9 hours)

Combustion chamber designs for SI and CI engines: Different combustion chamber designs in SI engines, DI and IDI Combustion chambers in CI engines. (3 hours)

Engine pollutant formation and control: Introduction to pollution, Nitrogen Oxides, kinetics of NO_X formation in SI engine and CI engine. CO emission, UBHC emission, flame quenching, HC emission from SI and CI engines. Particulate emissions, soot formation, oxidation and adsorption and condensation. (8 hours)

Emission control methods and modern developments: Exhaust and non-exhaust emissions: Exhaust emission control methods- thermal reactors, catalytic converters and particulate traps, chemical methods like ammonia injection. EGR technique, Non- exhaust emissions - evaporative emissions and crank case emissions and its control. Wankel engine, Stratified charge engine. (8 hours)

TEXT / REFERENCES:

- John B. Heywood, Introduction to Internal Combustion Engines, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
- Lichty L.C., International Combustion Engines, McGraw Hill, New Delhi, 1951.
- Edward F. Obert, Internal Combustion Engines and Air Pollution, Harper & Row, Publishers. Delhi, 1973.
- Ganeshan V., Internal Combustion Engines, (3e), Tata McGraw Hill Education Private Limited, New Delhi, 2007.
- Mathur and Sharma, A Course in I C Engines, Dhanpath Rai Publishers, New Delhi, 1981.
- Richard Stone, Introduction to Internal Combustion Engines, The McMillan Press, New Delhi, 1999.

METROLOGY AND MEASUREMENTS

IME 244 **3- 0 -0 –3**

Measurements and measurement systems: Methods of Measurement, Generalized Measurement System & its elements, Static Characteristics of Instruments & measurement systems: Accuracy, Precision, Sensitivity, Reproducibility, Repeatability, Linearity, Hysteresis. Threshold, Dead zone, Resolution. Errors in Measurement. (3 hours)

Measurement of pressure: Definition of Pressure. List of instruments used to measure pressure. Methods of pressure measurement - Elastic pressure elements (Bourdon Tube, Bellows, Diaphragm), McLeod Gauge and Bridgman gauge, Related problems. (4 hours)

Measurement of temperature: Methods of temperature measurement Pressure thermometer, Electrical Resistance thermometer, Thermocouples, Pyrometer (Disappearing filament type optical pyrometer) & Problems, Bimetallic thermometer. (3 hours)

Measurement of strain: Types of electrical resistance strain gauges, Theory of operation of wire wound strain gauge, Gauge Factor, Strain gauge bridge circuit, Calibration Circuit, Temperature compensation, Strain measurement on static and rotary shaft, Orientation of strain gauges. Simple problems related to measurement of strain using strain gauge. (5 hours)

Measurement of force, torque and shaft power: Measurement of Force - Hydraulic & Pneumatic load cells, Proving ring, Strain gauge load cell & related problems. Methods of Torque & Shaft power - Cradled dynamometer, Torque Meter, Band Brake dynamometer, Water Brake dynamometer. (3 hours)

Limits, Fits and Tolerances: Terminology (as per Indian Standards IS 919), Grades of Tolerances, Letter symbols for tolerances, Fits – definition, Types of fits – Clearance, Interference and Transition. Simple numerical on limits and fit. (3 hours)

Gauges: Taylor's principle for design of gauges – Statements and explanation, Gauge Maker's tolerance – as per 3rd system (present British standards), Numerical on design of gauges (complete shaft and hole pair) ,Types of gauges – Plug gauge, Ring gauge, Taper plug gauge, Taper Ring gauge and slip gauges. (3 hours)

Measurement of form errors: Straightness measurement– using straight edge, using Autocollimator. Squareness measurement – Engineer's Square tester, Optical Square. Simple numerical on Straightness, Flatness and Squareness measurement. (4 hours)

Surface texture measurement: Definitions - I, II, III, IV order (including their causes), Roughness and Waviness, Lays, Indian standards symbols for Roughness, Analysis of traces – R_a, R_z, R_t, R_q, Sampling length, h_{rms} and Centerline Average (CLA), Simple numerical on surface roughness. (4 hours)

Screw threads: Definitions of elements of external screw threads, Pitch error in threads: Progressive and Periodic, Measurement of the elements of the threads – Effective diameter using screw thread micrometer, two wire and three wire methods, Best size wire, Simple numerical on screw threads. (4 hours)

TEXT / REFERENCES:

- Beckwith Thomas G., Mechanical Measurements, Pearson Education, Delhi, 2003.
- Jain R.K., Engineering Metrology, Khanna Publishers, New Delhi, 1997.

- Sawhney A.K., Mechanical Measurement & Instrumentation, Dhanpat Rai & Co, New Delhi, 2002.
- Nakra B.C. and Chaudry K.K., Instrumentation, Measurement & Analysis, Tata McGraw Hill, New Delhi, 2002.
- Gupta I. C., Engineering Metrology, Dhanpat Rai Publications, New Delhi, 1997
- ASTME, Handbook of Engineering Metrology, Prentice Hall of India, New Delhi, 1972
- Raghavendra N.V. and Krishnamurthy L., Engineering Metrology and Measurements, Oxford University Press, 2013.

FLUID MECHANICS LABORATORY

IME 245 **0- 0 -3 –1**

List of Experiments:

1. Measurement of flow using Venturimeter
2. Measurement of flow using Orifice meter
3. Calibration of V notch and Rectangular notch
4. Calibration of Orifice
5. Measurement of force due to impact of jet on vanes
6. Determination of friction factor of pipes
7. Performance test on Hydraulic ram
8. Performance test on single stage and two stage Centrifugal pump
9. Performance test on Reciprocating pump
10. Performance test on Gear pump
11. Performance test on Impulse turbine
12. Performance test on Impulse - reaction turbine

TEXT / REFERENCES:

- Jagadishlal, Fluid Mechanics & Hydraulic Machines, Metropolitan Book Co. Pvt. Ltd New Delhi,1995.
- Bansal R K., Fluid Mechanics and Hydraulic Machines, Laxmi Publication, New Delhi, 2006.

WORKSHOP PRACTICE

IME 246 **0- 0 -6–2**

List of Exercises:

1. Preparation of Welded joints using Arc Welding
2. Use of TIG and MIG Welding techniques
3. Preparation of models using Lathe operations such as Plain turning, Step turning, Knurling, Chamfering, Taper turning and Thread cutting.
4. Preparation of models using CNC Turning Centre operations such as Facing, Turning, Profile Cutting, Taper Turning, Threading, Grooving and Chamfering.
5. Shaping Practice: Shaping of Flat surfaces, inclined surfaces and Cutting of slots.

Mini project: Preparation of models used in mechanical engineering applications.

TEXT / REFERENCES:

- Hajra Choudhury S. K., Hajra Choudhury A. K. and Nirjhar Roy, Elements of Workshop Technology Vol.1, Media Promoters & Publishers Pvt. Ltd., Mumbai, 2004.
- Raghuvanshi B. S., A Course in Workshop Technology Vol.1, Dhanpat Rai & Sons, Delhi, 1989.
- Peter Smid, CNC Programming Hand book, Industrial Press, New York, 2000.

THERMAL ENGINEERING LABORATORY

IME 247 **0- 0 -3–1**

List of Experiments:

1. Determination of viscosity of oil using viscometers
2. Determination of flash and fire point of oil using open cup and closed cup apparatus
3. Determination of lower calorific value of gaseous fuel using Boy's Gas Calorimeter
4. Determination of dryness fraction of steam using separating and throttling calorimeter
5. Performance test on single cylinder, low speed, 4 stroke, vertical diesel engine
6. Performance test on single cylinder, low speed, 4 stroke, vertical petrol engine
7. Measurement of area using Planimeter
8. Performance test on two stage Air Compressor
9. Performance test on rotary Air Blower
10. Performance test on MPFI engine
11. Morse test on a multi cylinder petrol engine
12. Performance test on Refrigeration plant and Air Conditioning plant

TEXT / REFERENCES:

- Ganeshan V., Internal Combustion Engines (3e), Tata McGraw Hill, Education Private Limited New Delhi, 2007.
- Mathur M. L. and Sharma R. P., Course in Internal Combustion Engines, Dhanpath Raj Publishers, New Delhi, 2001.

V SEMESTER

PROJECT WORK

IME 351 **0-0-36-12**

Students need to form batches with maximum four in numbers and required to identify the problem in their area of interest within their discipline of study under the supervision of a faculty (Guide) for 12 to 14 weeks. At the end, the findings need to be presented in the form of a project report for final evaluation.

VI SEMESTER

PRODUCTION AND OPERATIONS MANAGEMENT

IME 361 **3-1-0-4**

Introduction: Introduction to production and operations management, Types of production systems- continuous, job order and custom work, Production consumption cycle, Functions of production and operations management. Organization aspects, Centralized and decentralized production planning. (5 hours)

Plant location: Factors affecting plant location, Qualitative methods of location, Quantitative methods of location- Load distance method and Centre of gravity analysis. (3 hours)

Product development and design: Factors affecting product development and design, Product analysis, Economic analysis, Standardization, Simplification and Specialization, Preferred numbers, Product life cycle, Process analysis, Use of outline process chart, flow process chart and activity charts. Production master programs. (6 hours)

Capacity planning: Design capacity, System Capacity and System Efficiency, Factors affecting system capacity, Steps in capacity planning, Determination of equipment and manpower requirements, Decision tree analysis for capacity planning, Breakeven analysis in capacity planning, single and multi-product P-V charts. (5 hours)

Forecasting: Importance and uses of forecasting, Type of forecasts, Qualitative methods of forecasting - Historical estimate, Sale force estimate, Market Research and Delphi methods, Quantitative methods of forecasting – Simple and Weighted moving averages, Exponential smoothing, Linear regression analysis, Correlation analysis and Seasonality, Forecast control - Measures of forecast accuracy. (8 hours)

Aggregate planning: Pure and mixed strategies of aggregate planning, Aggregate planning using trial and error approach. (4 hours)

Job shop scheduling: Meaning and importance, Factors affecting job shop scheduling, Index method, Priority sequencing rules such as FCFS, SPT, EDD and Critical Ratio, Determination of mean flow time, average job lateness and average number of jobs in the system, Sequencing of ‘n’ jobs through 2 machines, ‘n’ jobs through 3 machines and 2 jobs through ‘n’ machines. (6 hours)

Inventory management: Introduction, Classification of inventories, Economic order quantity, Inventory control models – EOQ determination with instantaneous delivery and finite delivery and with or without shortages, Effect of quantity discount, Safety stock, Reorder level, lead time, ABC Analysis. (8 hours)

MRP: Introduction, Product structure tree, MRP inputs & outputs, MRP logic, Problems. (3 hours)

TEXT / REFERENCES:

- Monks Joseph G., Operations Management, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2004.

- Krajewski Lee J. and Ritzman Larry P., Operations Management, Pearson Education (Singapore) Pte. Ltd., Delhi, 2005.
- Adam Everett E. Jr. and Ebert Ronald J., Production and Operations Management, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
- Chase Richard B., Aquilano Nicholas J. and Jacobs F. Roberts, Production and Operations Management, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1999.
- Eilon Samuel, Elements of Production Planning and Control, Universal Publishing Corporation, Mumbai, 1991.
- Gupta Prem Kumar and Hira D. S., Operations Research, S. Chand & Co. Ltd., New Delhi, 2003.

HEAT TRANSFER

IME 362 **3-1-3-5**

Introduction: Modes of heat transfer, governing laws and its derivatives, concept of driving potential, thermal resistance and conductance, combined mechanism of heat transfer, overall heat transfer coefficient, initial and boundary conditions. (4 hours)

Steady state conduction: General heat conduction equation in Cartesian coordinates, thermal diffusivity, heat conduction through plane and composite walls, thermal contact resistance, radial heat flow through cylinder and composite cylinders, critical thickness of insulation, radial heat flow through sphere and composite spheres, log mean and geometric mean area, plane, cylinder and sphere with uniform rate of internal heat generation, effect of variable thermal conductivity. Heat transfer from extended surfaces: General energy equation for the fin, heat transfer from fin of uniform cross section heated at one end and both ends, efficiency and effectiveness, error in thermometry. (15 hours)

Convection heat transfer: Introduction, application of dimensional analysis to free and forced convection, dimensionless numbers and their physical significance, characteristic length, boundary layer concept, hydrodynamic and thermal boundary layer in external and internal flow, empirical correlations for forced and free convection. (6 hours)

Boiling and condensation: Fundamentals of boiling heat transfer, boiling regimes, correlations for boiling, film and drop-wise condensation, Nusselt theory, heat transfer in condensation. (4 hours)

Heat exchangers: Types of heat exchangers, fouling factor, overall heat transfer coefficient, analysis of parallel and counter flow heat exchanger – LMTD and NTU method, LMTD correction factor, heat transfer in evaporators and condensers. (6 hours)

Radiation: Thermal radiation, absorption, reflection and transmission of radiation, black body, Stefan-Boltzmann, Kirchoff's, Planck's and Wien's displacement Laws, radiation intensity and total emissive power, Heat transfer between black surfaces and between gray surfaces, radiation shields, electrical analogy of solving radiation problems (only between two bodies/surfaces). (9 hours)

Transient conduction: Introduction, lumped parameter analysis, Biot and Fourier number, time constant and response of temperature measuring instruments. (4 hours)

TEXT / REFERENCES:

- Holman J. P., Heat Transfer, (10e), Tata McGraw Hill, 2011.
  Ozisik M.N., Heat Transfer – A Basic Approach, (2e), McGraw Hill, 1985.
- Yunus A. Cenzel and Afshin J. Ghajar, Heat and Mass transfer, (4e), Tata McGraw Hill, 2013.

- Thirumaleshwar M., Fundamentals of Heat and Mass Transfer, (1e), Pearson Education, 2006.
- Rajput R.K. Heat and Mass Transfer, (4e), S Chand Publishing, 2008.

HEAT TRANSFER LABORATORY:

List of Experiments:

1. Heat transfer through free convection
2. Heat transfer through forced convection
3. Heat transfer through pin fin.
4. Heat transfer through composite wall and cylinder
5. Thermal conductivity of insulating powder and metals
6. Analysis of parallel and counter flow heat exchanger
7. Analysis of shell & tube heat exchanger
8. Measurement of emissivity
9. Calibration of thermocouples
10. Determination of Stephen Boltzman constant

TEXT / REFERENCES:

- Holman J. P., Heat Transfer, (10e), Tata McGraw Hill, 2011.
- Yunus A. Cenzel and Afshin J. Ghajar, Heat and Mass Transfer, (4e), Tata McGraw Hill, 2013.

ELECTIVE – I

IME 363 **3-0-0-3**

AUTOMATIC CONTROL ENGINEERING:

Concepts: Simple open and closed loop systems, concept of feedback, block diagrams, transfer functions. Representation of Control Components and Systems Representation, differential equations for mechanical systems, electrical systems, hydraulic systems and thermal systems, Integrating devices, hydraulic servomotor, temperature control system, speed control system, Liquid level Control System, and Flow Control System, Block representation of system elements, example of the use of block diagrams, Block diagram Reduction. (5 hours)

System responses: Damping ratio and natural frequency, First order and second order system response to step input, Ramp input and sinusoidal input, response of a system to external disturbance. Modes of control, characteristics of proportional control, integral control, derivative control, proportional plus derivation control and two position control. System type numbers and steady-state error, System stability criteria, Routh criteria, system types. (6 hours)

Frequency response: Polar and rectangular plots for the frequency response, graphical view point, experimental determination of frequency response, System analysis using polar plots (Nyquist criterion). (5 hours)

System analysis using logarithmic plots: Bode diagrams: Stability analysis using Bode diagrams, simplified Bode diagrams. (5 hours)

System analysis using root locus plots: Root Locus plots for simple transfer functions, graphical relationships setting the system gain, system transient response, system frequency response. (5 hours)

System compensation: Series and feedback compensation physical devices for system compensation. (4 hours)
Digital computer control: Concepts and control configurations, An example of direct digital control, Difference Differential equations. (3 hours)
State space analysis of control systems: Analysis of systems, Concept of state, state variable and state model, state model of linear systems, Eigen Values, Transfer function derivation from the state model, Solution of time invariant state equation. (3 hours)

TEXT / REFERENCES:

- Harrison H.L. and Bollinger J.G., Automatic controls, (2e), International Text Book Co. U.S.A., 1968
- Raven, Automatic Control Engineering, McGraw Hill , U.S.A., 1995.
- Benjamin.Kuo.C., Automatic Control Systems, EEE, (7e), Prentice Hall of India Ltd. New Delhi, 1995.
- Verma S.N., Automatic Control Systems, Khanna Publishers, Delhi, 1990.
- Katsuhiko Ogata, Modern Control Engineering, Prentice Hall of India Ltd., New Delhi. 2004.
- Gopal M, Modern Control Systems, New Age International Publisher, 2005.
- Narendra Singh Beniwal and Ruby Beniwal, Automatic Control Systems with MATLAB Programming, University Science Press, New Delhi, 2009.

SUPPLY CHAIN AND LOGISTICS MANAGEMENT:

Introduction: Introduction to supply chain, Objective of a supply chain, Importance of supply chain decisions, Decision phases in a supply chain, Process view of a supply chain, Examples of a supply chain. (3 hours)

E Business: Role of distribution in the supply chain, Factors influencing distribution network design, Design options for a distribution network, Indian agricultural produce distribution channels, Distribution networks in practice. (6 hours)

Network design: Role of network design in supply chain, Factors influencing network design decisions, framework of network design decisions, Models for facility location and capacity allocations, Role of IT in network design, Making network design decisions in practice. (6 hours)

Transportation: Role of transportation in supply chain, Modes of transportation and their performances, Transportation infrastructures and policies, Design options for a transportation network, Trade-offs in transportation design, Tailored Transportation, Role of IT in transportation, Risk management in transportation, Making transportation decisions in practice. (5 hours)
Sourcing decisions: Role of sourcing in supply chain, In-house outsource, Third and fourth party logistics providers, Supply scoring and assessment, Supplier selection – auctions and negotiations, Contracts and supply chain performance, Design collaborations, procurement process, Sourcing planning and analysis, Role of IT in sourcing, Risk management in Sourcing, Making sourcing decisions in practice. (8 hours)

Pricing and revenue management :Role of pricing and revenue management in supply chain, Pricing and revenue management for multiple customer segments, pricing and revenue management for perishable assets, Pricing and revenue management for seasonal demand,

pricing and Revenue management for bulk and spot contracts, Role of IT in pricing and revenue management, Using pricing and Revenue management in practice. (5 hours)

Information Technology: Role of IT in supply chain, Customer relationship management, Internal supply chain management, Supplier relationship management, Transaction management foundation, Future IT in supply chain, Risk management in IT, Supply chain IT in practice. (3 hours)

TEXT / REFERENCES:

- Shapiro J., Modelling the Supply Chain, Duxbury Thomson Learning, U.S.A., 2009.
- Chopra and Meindl., Supply Chain Management – Strategy, Planning and Operation, (3e), Pearson Education, New Delhi, 2009.
- Raghuram and Rangaraj, Logistics and Supply Chain Management: Cases and Concepts, Macmillan, New Delhi, 2000.
- Simchi-Levi and Kaminski, Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies , McGraw-Hill, 2003.

ELECTIVE – II

IME 364 **3-0-0-3**

ELEMENTS OF MECHATRONICS SYSTEMS:

Introduction: Definition, basic concepts and elements of mechatronic systems, needs and benefits of mechatronics in manufacturing. (3 hours)

Sensors and Transducers: Displacement Sensor - Linear and rotary potentiometers, LVDT and RVDT, incremental and absolute encoders. Temperature – Thermocouple, Thermistor, , Motion – Accelerometers, Velocity sensors – Tachometers, Proximity and Range sensors – Eddy current sensor, ultrasonic sensor, laser interferometer transducer, inductive proximity switch.Light sensors – Photodiodes, phototransistors, Flow sensors – Ultrasonic sensor, laser Doppler anemometer, tactile sensors – PVDF tactile sensor, vision sensor. (8 hours)

Drives and Actuators: Solenoids, relays, DC motors, Servo motor, BLDC Motosr, AC Motors, stepper motors, Piezoelectric actuators, Shape memory alloys. Hydraulic & Pneumatic devices – Power supplies, valves, cylinder sequencing. (7 hours)

Data acquisition and translation and presentation systems: Signal conditioning – Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, Multiplexer, Counters, decoders, ADC, DAC. Display-LED, LCD, Printers, Magnetic Recording. (8 hours)

Controllers and Algorithms: Microprocessor – Fundamentals, architecture of 8085, programming of 8085, Microcontrollers, Programmable Logic Controllers (PLC). (7 hours)
Applications: NC/CNC machines, robots, automatic camera, temperature monitoring system, engine management system, washing machine. (3 hours)

TEXT / REFERENCES:

- Alciatore David G and Histand Michael B, Introduction to Mechatronics and Measurement Systems, Tata McGraw Hill, 2003
- Bolton W., Mechatronics, Addison Wesley Longman Ltd., 1999.
- Devdas Shetty & Richard Kolk, Mechatronics System Design, PWS Publishing.
- Dan Nesculescu, Mechatronics, Pearson Education Pvt. Ltd., 2002.

NON - CONVENTIONAL ENERGY SOURCES:

Introduction: Energy-different forms of energy, Energy sources, Need for renewable energy sources, India's production and reserves of Commercial energy sources and potential of Renewable energy resources, Benefits and limitations. (3 hours)

Solar energy and radiation: Solar air heaters, Cooking, Drying, Distillation, Space heating, Refrigeration, Power generation-low, medium and high temperature cycle. Solar radiation - Solar constant, Solar radiation at the earth's surface, Measurement of solar radiation, solar radiation geometry (Basic earth sun angles and derived solar angles), Empirical equations for predicting the availability of solar radiation, solar radiations on tilted surface, Numerical examples. (5 hours)

Liquid flat-plate collectors: Principles of the conversion of solar radiation into heat, Description of flat plate collector, Performance analysis, Transmissivity of cover systems, Transmissivity-absorptivity product, Overall loss coefficient , One dimensional analysis, Collector efficiency factor and Heat removal factor, Numerical examples, Effects of various parameters on performance testing. (5 hours)

Wind energy: Principles of wind power, Total power, maximum power (Betz theory), Actual power, Types of windmill, Wind turbine operation, Forces on the blades and thrust on turbines, Numerical examples, Site selection, Advantages and limitations. (4 hours)

Ocean energy: Wave energy, energy and power from the wave. Wave energy conversion by floats - Oscillating float air pump and Buoy-Dolphin type, Numerical examples, Advantages and limitations. Tidal energy, Tidal energy conversion by single pool system and two pool system, Numerical examples, Advantages and limitations. Principle of OTEC, Open cycle, closed cycle and hybrid cycle systems, Advantages and limitations. (4 hours)

Hydel plant and Geothermal energy: Small scale hydel plant: Classification, Scope, Bulb turbine, Tube turbine, Advantages and limitations. Geothermal energy conversion: Principle of working, Hydrothermal and Petro-thermal systems, Advantages and limitations. (5 hours)

Biomass energy: Types of biomass, Biogas production from organic waste by an aerobic fermentation – three stages of production, Influencing factors for the generation of biogas, Types of biogas plants – floating gas holder plant, Fixed dome plant, Community biogas plant, Numericals on cow-dung digester (Design is not involved), Ethanol production – from wood by acid hydrolysis and from sugar cane, Thermo-chemical method of bio-conversion-combustion-updraft gasifier and down draft gasifier, pyrolysis method. (5 hours)

Direct energy conversion: Conversion of thermal energy into electricity – Thermo-electric converters, Thermo- ionic converters, numerical examples, Conversion of chemical energy into electricity-Fuel Cells, H_2-O_2 acidic fuel cell, Conversion of electromagnetic energy into electricity-Working principle of solar cells, MHD generators, Types of MHD converters, related numerical examples. (5 hours)

TEXT / REFERENCES:

- Culp A.W., Principles of Energy Conversion, McGraw Hill International, 2001.
- Sukatme S. P., Solar Energy Principles of Thermal Collection and Storage, Tata Mc Graw Hill, 2005.
- El-Wakil M M, Power plant Technology, McGraw Hill International, 1984.
- Rai G. D., Non-conventional Energy Sources, Khanna Publications, 1997.
- Rao S and Dr. Parulekar B. B., Energy Technology, Khanna Publishers, 2004.

ELECTIVE – III

IME 365 **3-0-0-3**

HEAT TREATMENT OF METALS AND ALLOYS:

Iron-Carbon equilibrium diagram and fundamentals of heat treatment: Iron-Carbon equilibrium diagram and Lever rule application, Effect of alloying elements on the diagram, Principles of Heat treatment of steels, Decomposition of austenite - TTT diagram, Effect of alloying elements on TTT diagram, CCT curves, Pearlitic transformation, Bainitic transformation & Martensitic transformations. (8 hours)

Heat treatment processes: Annealing and its types, Normalising, Hardening and its different methods, Tempering, Hardenability, Determination of hardenability – Grossman's critical diameter method, Jominy end quench test, Factors affecting hardenability. (7 hours)

Case and surface hardening treatments: Case hardening – Carburizing and its Types, Post carburizing treatments, Cyaniding and Carbonitriding, Nitriding, Plasma nitriding, Boronizing & Chromizing. Thermal treatments: Flame hardening, Induction hardening, Electron beam hardening, Laser hardening. (6 hours)

Age hardening and thermo-mechanical treatments: Controlled rolling, Ausforming, Isoforming, Marstraining, Cryoforming, Thermomechanical annealing, Thermomechanical treatment of non-ferrous alloys. (5 hours)

Steel specification, classification and heat treatment of Steels and Cast iron: IS and AISI classification of steel, Heat treatment and Application of plain carbon steels, Commercial steels, high speed steels, Stainless steels, Maraging steels, Spring, Valve, Bearing and HSLA steels, Cast iron and Heat treatment- Grey, White cast irons, Malleable iron, Malleabilization of white cast iron, Spherioidal graphite (SG) iron. (7 hours)

Heat treatment and application of non-ferrous metals and alloys: Aluminium alloys, Titanium alloys, Copper alloys, Defects, Causes and Remedies in heat treatment. (3 hours)

TEXT / REFERENCES:

- Thelning K. E., Steel and its heat treatment, Butterworth/Heinemann, Oxford, 2000.
- Rajan T. V., Sharma C.P and Alok Sharma, Heat treatment principles and techniques, PHI Publication, Delhi, 1999.
- Bolton W., Engineering materials technology, Heinmann Newness, New Delhi, 2001
- Romesh C. Sharma, Principles of Heat Treatment of Steels, New Age International (P) Limited, New Delhi, 1996.
- Vijendra Singh, Heat Treatment of Metals, Standard Publishers Distributors, Delhi, 2012.
- Avner S. H., Introduction to Physical Metallurgy, (3e), McGraw Hill, New Delhi, 2004.
- William D. Callister, Materials Science and Engineering, John Wiley & Sons, 2007.

POWER PLANT ENGINEERING:

Introduction : Choice of site for power station, load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, demand factor, effect of variable load on power plant, selection of the numbers and size of units, Economics of power generation. (5 hours)

Hydro-Electric plants: Storage and pondage, flow duration and mass curves, hydrographs, low, medium and high head plants, pumped storage plants, penstock, water hammer, surge tanks,

gates and valves, power house, general layout. (5 hours)

Steam power Plant: Different types of fuels used for steam generation. Equipments for burning coal in lump form - stokers, different types, oil burners. Advantages and disadvantages of using pulversied fuel. Equipment for preparation and burning of pulverised coal, unit system and bin system. Pulversised fuel furnaces, cyclone furnace. Coal and ash handling. Dust collection systems-Electrostatic Preciptator. (7 hours)

Boiler accessories and chimneys: Generation of steam using forced circulation, high and supercritical pressures. A brief account of La Mont, Benson, Velox, Schmidt and Loeffler. Natural, forced, induced and balanced draft. Calculations involving height of chimney to produce a given draft.Accessories for the steam generator such as superheaters, desuperheaters, control of superheaters. Economisers, Air Pre-heaters and re-heaters. Cooling towers and ponds: Different types. (7 hours)

Diesel and Gas turbine plant: Engines for Power generation: General arrangement of Diesel Power Plant, Fuel storage and supply system, Cooling and lubrication system, Filters, centrifuges, oil heaters, Intake and exhaust system, Supercharger, Methods of starting the diesel engine, Layout of a diesel power plant. Gas Turbine Power Plant: Advantages and disadvantages of the gas turbine plant. Open and closed cycle turbine plants with its accessories. (6 hours)

Nuclear power plant: Principles of release of nuclear energy. Fusion and fission reactions. Nuclear fuels used in the reactors. Multiplication and thermal utilisation factors. Elements of the Nuclear reactor. Moderator, control rod, fuel rods, coolants etc. Brief description of reactors of the following types: Pressurized water reactor and PHWR, Boiling water reactor, Sodium graphite reactor, Fast Breeder reactor. Homogeneous reactor, Waste disposal. (6 hours)

TEXT / REFERENCES:

- Frederick.T.Morse, Power Plant Engineering, East West Press.
- Skrotzki and Vopat, Power Station Engineering Economy, McGraw Hill Book Co.
- Wrangham D.A., Theory and Practice of Heat Engines, ELBS Edition.
- R.K .Rajput, Power Plant Engineering, Laxmi Publication (P) Ltd, 2010
- P.K.Nag, Power Plant Engineering, Tata McGraw Hill Publishing Co. Ltd, 2008.
- G.R.Nagpal, Power Plant Engineering, Khanna Publishers, 2008.
- M.M. El. Wakil, Power Plant Technology, McGraw Hill International.

ELECTIVE – IV

IME 366 **3-0-0-3**

OPERATIONS RESEARCH:

Introduction: Definition, Phases, Applications, Advantages and Limitations of Operations Research. (3 hours)

Linear programming problems: Assumptions, Formulation of LPP for business and non-business applications. Graphical solutions, Special cases – Degeneracy, Infeasible Solution, Unbalanced and Multiple optimal solutions. Minimization and Maximization cases. Simplex algorithm, Concept of dual, Sensitivity analysis with respect to objective function coefficients and R.H.S. values. (11 hours)

Transportation problem: Formulation, Generating initial solutions using North-West Corner (NWC) Method, Least Cost (LC) Method, Vogel's Approximation Method (VAM). Testing the solution by Stepping stone, Modified Distribution (MODI) Method. Maximization, Multiple

optimal solutions, Degeneracy and Unbalanced problems. Post optimality analysis. (3 hours)
Assignment problem: Solution algorithm for Assignment Problem. Unbalanced, multiple optimal solutions, Maximization and Application problems. (3 hours)

Travelling salesman/Job sequencing problem: Solution algorithm for Travelling Salesman Problem, Application to job sequencing problem (3 hours)

Game theory: Introduction to game theory, Two-person-zero sum games, Pure and Mixed Strategies, Solution methods for 2 x 2 games, Graphical method (2 x n games; m x 2 games), approximate method, Formulation as a L.P.P. (3 hours)

Queuing theory: Introduction to queuing theory, Poisson arrival rate and Exponential service times, System characteristics, Problems on the models- (M/M/1):(∞/FIFO), (M/M/1) : (N/FIFO), Simulation of queuing models - Steps in simulation, Application and Limitations, Monte- Carlo technique-Problems involving Waiting line situations and Selection of crew members. (3 hours)
Critical Path Method (CPM): General frame work, Introduction to elements of network, conventions adapted in drawing network, Analysing the network. Calculation of event and Activity times, Total Float, Free Float, Independent float, Critical path, Determination of project duration, Project Crashing. Applications and Limitations of CPM. (3 hours)

Project Evaluation and Review Technique (PERT): Calculation of Probabilistic/Expected event and Activity times, Variance of activity duration, Determination of critical path, probability/expectation of project completion. (3 hours)

TEXT / REFERENCES:

- Taha H. A., Operations Research, Pearson Education, (7e), 2002.
- W.L. Winston, Operations Research, Thomson Asia, 2003.
- Vohra N. D., Quantitative Techniques in Management, New Delhi, 2007.
- Sharma S. D., Operations Research, Kedar Nath Ramnath Publications, (14e), 2005
- Kanthiswaroop, Gupta and Manmohan, Operations Research, Sultan Chand and Sons.
- Hervey M. Wagnor, Principles of Operations Research, Prentice Hall of India Private Ltd.
- Paul Loomba, Management, A Quantitative Perspective, MacMillan, New York, 1978.

ORGANIZATIONAL BEHAVIOR:

Introduction: Definition of Organization Behaviour (OB), Contributing disciplines to OB, Basic OB Model. (3 hours)
Learning: Definition, Theories of learning: Classical & Operant Conditioning), Methods of shaping behaviour: Positive and Negative reinforcement, Schedule of reinforcement. (3 hours)

Values, attitudes and job satisfaction: Values: Definition, Types of values, Values across cultures. Attitudes: Definition, Components of attitudes, Sources of attitudes, and Types of attitudes: Job Satisfaction, Job involvement and Organizational commitment Determinants of Job satisfaction. (4 hours)
Personality: Determinants of Personality, Personality theories (MBTI and Big Five Model), Major personality attributes: Locus of Control, Machiavellianism, Self- Esteem, Self-Monitoring and Risk Taking. (4 hours)
Perception: Definition, Factors influencing perception, Attribution Theory, Selective perception, Halo effect, Contrast effect, Stereo-typing. (4 hours)

Basic motivation concepts: Definition, Maslow's hierarchy of needs, Theory X and Theory Y, Frederick Herzberg's Motivation and Hygiene Theory, Contemporary Theories: ERG, Davis McCleland theory of needs, Vroom's Expectancy theory, The Job Characteristic Model, Job Rotation, Job Enlargement and Job Enrichment. (4 hours)

Group dynamics: Group: Definition, Classification of groups, Stages of group development, Group Behaviour Model. (4 hours)
Leadership: Definition, Quality of a good leader, types and theories of leadership. (3 hours)

Conflict: Definition, Functional Vs Dysfunctional Conflict, Conflict Process, Dimensions of Conflict Handling Intentions. (3 hours)
Organizational change and Organizational development: Organizational Change: Forces for change, Resistance to Change, Lewin's Three-Step Model and Action research, Organizational Development (OD). (5 hours)

TEXT / REFERENCES:

- Schermeshorn John R., Managing Organizational Behaviour, John Wiley, New York, 1982.
- Robbins Stephen P., Organizational Behaviour, Prentice Hall of India, New Delhi, 2004.
- Luthans Fred, Organizational Behaviour McGraw Hill, New York, 1989.
- Gupta Rakesh, Organizational Behaviour, Kitab Mahal,Allahabad, 1998.
- Davis Keith and Newstrom J.W., Organizational Behaviour at Work, Tata-McGraw Hill , New Delhi, 1997.
- Moorhead Greogery and Griffin Ricky W., Organizational Behaviour, AITBS, New Delhi, 1999.
- Carrel Michaell R., Fundamentals of Organizational Behaviour, Prentice Hall, New Jersey, 1997.

SEMINAR

IME 367 **0-0-3-1**

Students need to present a seminar on a topic of recent developments in their subject filed.

B.Sc. (MECHATRONICS)

II SEMESTER

III SEMESTER

ELEMENTS OF MECHATRONIC SYSTEMS

IMET 231 **3– 0– 0 – 3**

Introduction: Definition, basic concepts and elements of mechatronic systems, needs and benefits of mechatronics in manufacturing. (1 hour)
Sensors and Transducers: Displacement Sensor - Linear and rotary potentiometers, LVDT and RVDT, incremental and absolute encoders. Strain - Strain gauges. Force/Torque - Load cells. Temperature – Thermocouple, Bimetallic Strips, Thermistor, RTD, Motion – Accelerometers, Velocity sensors – Tachometers, Proximity and Range sensors – Eddy current sensor, ultrasonic sensor, laser interferometer transducer, Hall Effect sensor, inductive proximity switch. Light sensors – Photodiodes, phototransistors, Flow sensors – Ultrasonic sensor, laser Doppler anemometer, tactile sensors – PVDF tactile sensor, micro-switch and reed switch. Piezoelectric sensors, vision sensor. (9 hours)
Drives and Actuators: Solenoids, relays, diodes, thyristors, triacs, BJT, FET, DC motor, Servo motor, BLDC Motor, AC Motor, stepper motors, Piezoelectric actuators, Shape memory alloys. Hydraulic & Pneumatic devices – Power supplies, valves, cylinder sequencing. (8 hours)

Data acquisition and translation: Signal conditioning – Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, Multiplexer, Pulse width Modulation Counters, decoders, ADC, DAC Signal Analysis - Linearization of data, Compensation, Signal Averaging, Fourier analysis. (7 hours)

Data presentation system: Display - Cathode ray oscilloscope, LED, LCD, Printers, Magnetic Recording. (2 hours)

Controllers and Algorithms: Microprocessor – Fundamentals, architecture of 8085, programming of 8085, Microcontrollers, Programmable Logic Controllers (PLC), Artificial Neural Networks (ANN), Fuzzy controls. (6 hours)

Applications: NC/CNC machines, robots, automatic camera, temperature monitoring system, engine management system, washing machine. Recent trends in mechatronics – MEMS, smart materials. (3 hours)

TEXT / REFERENCES:

- D.A. Bradley and others "Mechatronics" Chapman & Hall.
- W. Bolten (1999) 'Mechatronics', Addison Wesley Longman Ltd,
- Devdas Shetty & Richard Kolk "Mechatronics System Design", PWS Publishing.
- Dan Nesculescu (2002) 'Mechatronics', Pearson Education Pte. Ltd.
- Alciatore David G & Histand Michael B (2003) "Introduction to Mechatronics and Measurement systems", Tata McGraw Hill.
- 'Mechatronics – HMT', Tata McGraw Hill Publishing Company Ltd, 1998.
- Aditya P. Mathur (1989) 'Introduction to Microprocessors', Tata Mcgraw Hill
- Publishing Company Ltd.,
- C.R. Venkataramana (2001) 'Mechatronics', Sapna Book house, Bangalore.

KINEMATICS OF MACHINES

IMET 232 **2– 1– 0 – 3**

Basic Concepts: Mechanism and machine, kinematic pair, link, chain and inversions, constrained and unconstrained motions, four bar mechanism, single and double slider crank mechanisms with inversions, quick return mechanism, toggle mechanism, Hooke's coupling. (10 hours)

Velocity and Acceleration:Solution of simple mechanisms by relative velocity and acceleration method. (6 hours)

Cams: Types of cams, types of followers, cam profiles, graphical methods for S.H.M, Uniform velocity and Uniform acceleration and retardation, radial and oscillating followers.

Balancing: Balancing of rotating masses in single plane and different planes (Graphical Method).

(9 hours)

Toothed gearing: Spur gears, diametral pitch, module, pressure angle, tooth profile, characteristics of involute gear, interference path and arc of contact, contact ratio, minimum number of teeth. Terminology of helical, bevel and worm gears. (7 hours)

Gear trains: Simple, compound, reverted & epicyclic, solution by tabular method only. Tooth load, torque calculations (Automobile differential box included). (6 hours)

Belts and rope drives: Slip, belt thickness, length of belts, velocity ratio, ratio of tensions, maximum power. (5 hours)

Friction: Flat pivot and collar friction, power loss due to friction, problems on single plate and multiplate clutches. (5 hours)

TEXT / REFERENCES:

- Shigley, J.E. and Uicker(K), J.J. (1980), "Theory of Machines and Mechanisms", McGraw Hill
- Singh, V.P. (1998), "Theory of Machines", Khanna Publishers, New Delhi
- Rao, J.S. and Dukkipati, R.V. (1992), "Mechanism and Machine Theory", Second Edition,Wiley Eastern Ltd.
- Malhotra, D.R. and Gupta, H.C. (1998), "The Theory of Machines", Satya Prakashan,Tech. India Publications.
- Gosh, A., and Mallick, A.K. (1989), "Thoery of Machines and Mechanisms", Affiliated East West Press.
- Ballaney, P.L. (1998), "Theory of Machines", Khanna Publishers, New Delhi
- Burton Paul (1979), "Kinematic and Dynamic of Planer Machinery", Prentice Hall.

MATERIALS SCIENCE AND ENGINEERING

IMET 233 **3– 0– 0 – 3**

Introduction:
Need, purpose, and importance of the subject. Crystal Structures(cubic and HCP structures) – computations – packing factor of cubic and HCP structure, co-ordination number, Miller indices, crystal imperfections-point& line defects. (5 hours)

Solidification Mechanisms and Phase diagrams: Homogeneous and heterogeneous nucleation. Mechanism of solidification –nucleation and crystal growth, dendritic growth, Solid solutions and types, Intermediate phases, Equilibrium diagrams(only binary), –construction and explanation of isomorphous and eutectic systems, equilibrium and non-equilibrium cooling, invariant reactions (euctectic, peritectic, monotectic, eutectoid, and peritectoid) Lever rule and its application on isomorphous and eutectic systems and Iron – iron carbide system.
(10 hours)

Ferrous-alloys and Non-ferrous alloys: Principle and objectives of heat treatments Heat treatment of ferrous alloys,TTT diagram, annealing, normalizing, hardening, tempering and case hardening with heat treatment cycle, Composition, properties and applications of alloy steels. Types and explanation of brasses, bronzes and Al-Cu alloys and Lead tin alloys.
(5 hours)

Polymers and Composites: Classification of polymers,degree of polymerization, thermoplastics and thermosets, adhesives.disperssion strengthened composites particulate composites, fiber-reinforced composites and laminar composites. (5 hours)

Electronic, Magnetic and optical properties of materials: Conductivity of metals and alloys, deposition of thin films, insulators and dielectric properties, electrostriction, piezoelectricity and ferroelectricity, magnetic materials ,magnetization, magnetic field,ferro magnetic and supper paramagnetic materials, application of magnetic materials. Refraction, reflection, transmission, selective absorption and use of emission phenomena. (11 hours)

TEXT / REFERENCES:

- Donald R. Askeland & Pradeep P. Fulay, "The science and engineering of materials", Cengage learning publishers, 6th Edition 2011
- Lakhtin Yu., "Engineering Physical metallurgy and heat treatment", MIR Publishers, Moscow, 1985.
- Higgins R.A.," Engineering Metallurgy ", 5th Edition, ELBS, London,1983
- Avner S.H., "Introduction to Physical Metallurgy ", 3rd Edition, McGraw Hill. Delhi 2004 Arzamasov, "Material Science ", MIR Publishers, Moscow. 1989

ANALOG AND DIGITAL SYSTEM DESIGN

IMET 234 **3– 0– 0 – 3**

Operational amplifier: Differential amplifier, block diagram of op-amp, op amp parameters (AC & DC), open and closed loop operation of OP-AMP, frequency response, frequency compensation techniques. (4 hours)

Linear & non-linear applications of op-amp: Linear applications: adder, subtractor, integrator, differentiator, voltage follower, V-I and I-V converter, instrumentation amplifier non-linear applications: log and antilog amplifier, multiplier, divider, square root, active peak detector, rectifiers, clippers, clampers. Comparator and its applications, Schmitt trigger, window detector, sample & hold circuit. (10 hours)

Special functions: Multivibrators based on 555 and OP-AMP, PLL, VCO, ADC, DAC, three terminal regulator ICS, basic block schematic – 78XX & 79XX series - adjustable output voltage regulator LM 317 (6 hours)

Number system and codes: Binary, octal, hexadecimal and decimal number systems and their inter conversion, BCD numbers (8421-2421), gray code, excess–3 code, cyclic code, code conversion, ASCII, EBCDIC codes. Binary addition and subtraction, signed and unsigned binary numbers, 1's and 2's complement representation. (8 hours)

Combinational logic: The half adder, the full adder, subtractor circuit. Multiplexer de-multiplexer, decoder, BCD to seven segment decoder, encoders. (6 hours)

Flip flop and timing circuit: Set-reset laches, D-flip-flop, R-S flip-flop, J-K flip-flop, master slave flip-flop, edge triggered flip-flop, T flip-flop. (6 hours)

Registers & counters: Synchronous/asynchronous counter operation, up/down synchronous counter, application of counter, serial in/serial out shift register, serial in/serial out shift register, serial in/parallel out shift register, parallel in/ parallel out shift register, parallel in/serial out shift register, bi-directional register. (8 hours)

TEXT / REFERENCES:

- R.L.Boylestad, L.Nashelsky, "Electronic Devices and Circuit Theory", PHI 8th edition. 2003.
- Ramakant A. Gayakwad "Op-Amps and Linear Integrated Circuits", Prentice Hall of India. 1987.
- Choudhury Roy D, Shail B. Jain, "Linear Integrated Circuits", Wiley Eastern. 1991.
- Ananda Kumar, "Switching Theory and Logic Design", Prentice Hall of India, 2009.
- Morris Mano, "Digital design", Prentice Hall of India, (3e) 2002.

CAD LAB

IMET 235 **0– 0– 3 – 1**

2D Drafting of individual and assembled machine components
2D drafting of orthographic and sectional views of individual and assembled machine components like bearings, joints, and power screws plummer block, screw jack, knuckle joint etc. (3 hours)
3D modeling of machine components and assembly
3D modeling of simple machine parts like plummer block, bench vice, CPU fan, butterfly valve etc… and create a draft of the assembly. (6 hours)
Kinematic Simulation
Simulation of simple mechanisms to obtain position, velocity and acceleration parameters of different mechanisms like 4 bar mechanism, slider crank mechanism etc. (3 hours)

TEXT / REFERENCES:

- Sham Tickoo, CATIA – for Engineers and Designers, Dreamtech Press, New Delhi 2005.
- Gopalkrishna K. R., Machine Drawing, Subhas Publications, Bangalore, 2002
- Bhat N.D., Machine Drawing, Charotar Publishing House, Anand, 2002
- Venugopal K., Engineering drawing and graphics + Auto CAD, Newage International Publishers, Delhi 2002
- Narayana K.L. and Kannaiah P, Text Book on Engineering drawing, Scitech Publications, Chennai 2002
- Ibrahim K Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill, New Delhi, 1998

IV SEMESTER

IHS 241 – ENGINEERING ECONOMICS & MANAGEMENT

(Refer page no. **45**)

IEE 241 – SIGNALS AND SIGNAL PROCESSING

(Refer page no.**68**)

IEE 242 - MICROCONTROLLER LABORATORY

(Refer page no. **139**)

MICRO CONTROLLERS AND APPLICATIONS

IMET 241 **3- 0 -0 –3**

Introduction to microcontrollers, History of Micro controllers, Embedded versus External memory devices. Microcontroller survey, CISC and RISC Microcontrollers, Harvard and von Neumann Architecture, Commercial Microcontroller Devices. (2 hours)
Introduction to 8051 family, History of 8051, Architectural features of 8051, Programming model. Pin details, I/O Ports, Power down operation. (4 hours)
Addressing Modes, Instruction set of 8051 and Programming. (10 hours)

Programming the 8051 resources: Counters, Timers, Serial Interface, Interrupts, Measurement of frequency, period and pulse width of a signal. (8 hours)

Peripheral Interfacing – 8255, Memory interfacing, LCD, Stepper motor, Seven Segment Display, Digital to analog Converter, Analog to Digital converters, Case Study: Traffic Light Controller. (8 hours)
Introduction to PIC Microcontrollers- Architectural and Peripheral features, ALU, CPU, Memory map, clock, pipelining, addressing and I/O ports. (4 hours)

TEXT / REFERENCES:

- Kenneth J. Ayala, "The 8051 Microcontroller and Embedded Systems using Assembly and C", Cengage Learning, 2010.
- Muhammad Ali Mazidi, Janice Gillipse Mazidi, Rolin D. Mckinlay, "8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2010.
- Myke Predko, "Programming and Customizing the 8051 Microcontroller", Tata McGraw Hill Education Pvt. Ltd., 2000
- PIC micro Mid- Range MCU Family Reference Manual.
- Udayashankara, S. Mallikarjunaswamy, "8051 Microcontroller – Hardware, Software and Applications
- D. Karuna Sagar, "Microcontroller 8051", narosa Publishing House, 2011

PROGRAMMABLE LOGIC CONTROLLERS

IMET 242 **3- 0 -3 –4**

Introduction to PLC: What is PLC, Technical Definition of a PLC, Advantage of PLC, and Chronological Evolution of a PLC, Type of PLC, Parts of PLC and Block diagram PLC. I/O modules and interfacing, CPU processor, devices connected to I/O modules. Input-Output System Sinking and Sourcing, power supply module, PLC wiring Connection, Special I/O Modules. (6 hours)

PLC programming: programming Equipment, programming formats, construction of PLC ladder diagrams, Input and output instructions, operational procedures, programming examples using contacts and coils, latching, holding, drill press operation. Converting simple relay logic diagram to PLC ladder diagram.Digital logic implementation and conversion to ladder programming. (6 hours)

PLC functions: Timer functions and industrial applications, counters, counter function, Industrial applications, arithmetic functions, and number comparison. Data handling functions, and Bit pattern and changing a bit shift register, sequence functions. Analog PLC operation, Analog module systems, PID principles, position indicator with PID control, PID modules and networking of PLC (8 hours)

Applications of PLC: Materials handling applications Automatic control of warehouse door, Automatic lubricating oil supplier, Conveyor belt motor control, Automatic car washing machine Bottle label detection, controlling of two axis and three axis robot. (Case study) (4 hours)

Supervisory Control and Data Acquisition (SCADA) : SCADA introduction, brief history of SCADA, elements of SCADA. Features of SCADA. SCADA as a real time system, MTU-functions of MTU, RTU Functions of RTU, Protocol Detail, Communications in SCADA- types & methods used, components, Protocol structure and Mediums used for communications, SCADA Development for any one typical application. (case study). (8 hours)

Distributed Control System: Evolution of DCS, Architecture of DCS, Hierarchical structure, different functional levels, database organization for DCS, data communication link, reliability and consideration in DCS, flow sheet symbols and advantages of DCS. (4hours)

TEXT / REFERENCES:

- John .W.Webb and Ronald.A.Reiss,"Programmable logic controllers-Principle and applications" fifth edition, PHI.
- Hackworth and Hackworth F.D," Programmable logic controllers- Programming Method and applications", Jr- Pearson, 2004.
- Samuel M. Herb, "Understanding Distributed Processor Systems for Control", ISA Publication. 1999
- Thomas Hughes, "Programmable Logic Controller", 4/e, ISA Publication, 2004.
- Stuart A. Boyer, "SCADA supervisory control and data acquisition", 4/e, ISA Publication,2009.
- Madhuchanda Mitra and Samarjit Sen ,"Programmable Logic Controllers and Industrial Automation an Introduction", Penram International Publishing (India) Pvt.Ltd.
- W. Bolten ,"Programmable Logic Controllers "
- Kelvin Collins ,"Programmable Logic Controllers and Industrial Automation" Exposure Publishing.

PROGRAMMABLE LOGIC CONTROLLERS LABORATORY

To understand the working of a programming logic controller and to implement the digital logic in PLC, Tank Filling Device Simulator System, Supervise Equipment, Gate Control System, Buffer Store Simulation, Selective Band Switch, Star-Delta - Starting Up, Starter Control, Dahl Ander Pole Changing, Road Works Traffic Lights, Cleaning System.

Mini Project: At the end of the semester students have to submit a mini project where the sensors and actuators are interfaced to PLC. The logic for the project would be written in the PLC controller.

TEXT / REFERENCES:

- Mechatronics Training Practice Module, FESTO Manual Germany 2011.
- Siemens PLC Manual.
- PLC training practice module, BOSCH REXROTH Manual Germany 2011
- John W. Webb and Ronald A. Reiss, Programmable Logic Controllers - Principle and Applications, (5e), PHI.
- Hackworth and Hackworth F.D, Programmable Logic Controllers - Programming Method and Applications, Pearson, 2004.
- Festo Didactic Modular production system: processing, buffer, handling, distribution, storage station manual, Esslingen. 1996.

AUTOMATED MANUFACTURING SYSTEMS

IMET 243 **3- 0 -0 –3**

Numerical control production systems: Development in machine tools, introduction to NC technology, basic components of CNC system - part programming, machine control unit, machine tool. Design consideration of CNC machines, methods of improving machine accuracy and productivity, machine structure, guideways, , intepolators, control loops of CNC systems – control loop of point to point systems, control loop of contouring systems. (10 hours)

CNC programming: Concepts of CAM - tool path generation and control methods. Co-ordinate systems, CNC programming for turning center and machining center by manual method (word address format only), CNC programming with interactive graphics, manual data input, distributed numerical control, adaptive control machining system, automated inspection and testing: principle and methods, coordinate measuring machines. (8 hours)

Computer integrated manufacturing systems: Part families – part classification and coding, production flow analysis, computer integrated manufacturing system, types of manufacturing system, machine tools and related equipment. Flexible manufacturing system, FMS work station, types of FMS layouts, Analysis of FMS (Bottle neck model) Computer aided process planning, computer integrated planning systems., shop floor control. (8 hours)

Material handling and identification technologies: Introduction to material handling, material transport equipments, analysis of material transport systems. Storage system performance and location strategies, automated storage systems, Factory data collection - automatic identification and data capture, bar code technology, RFID in manufacturing. (8 hours)

TEXT / REFERENCES:

- Koren Yoram, "Computer Control of Manufacturing Systems, and Computer Integrated Manufacturing" McGraw Hill, Singapore. 1983.
- Groover Mikell P., "Automation, Production Systems, and computer Integrated manufacturing" Prenice Hall of India, New Delhi., 2003.
- Koren Yoram and Ben and Uri Joseph, "Numerical Control of Machine Tools", Khanna Publishers, New Delhi, 2005.
- Groover Mikell P. and Zimmers Emory W., "Computer aided design and manufacturing" Prentice Hall of India , New Delhi., 2003.
- Radhakrishnan P., "Computer Numerical Control Machines" New Central Book Agency (P) Ltd.,Kolkata., 2004.

INDUSTRIAL ROBOTICS

IMET 244 **3- 0 -0 –3**

Introduction: Definition of Robots; Types of Robots; Robot Generation; Classification of Robots; Degrees of Freedom; Degrees of Movements; Robot Configuration; End effectors; sensors and actuators;Selection of Robots; Definition and factor affecting the Control Resolution, Spatial Resolution, Accuracy and Repeatability; Specification of a robot; MTBF; MTTR; Need for industrial robots; Robot application; Robot programming languages.Economic, safety and social considerations. (12 hours)

Robot Kinematics and Dynamics : Kinematic analysis coordinate & vector transformation using matrices, the orientation matrix & translator vector, homogeneous transformation matrices, three dimensional homogeneous transformations, Denavit Hartenberg convention-implementing the dh convention, obtaining the dh displacement matrices. Applications of DH method- three axis robot arms, three axis wrists, six axis robot manipulators. Jacobian matrix for positioning, the Jacobian matrix for positioning & orienting, Inverse Jacobian. Differential motions.
(16 hours)

Trajectory planning: Introduction, the necessity of interpolators, the generation of motion commands, the trajectory planning, basic structure of interpolators. The solvability of the

inverse, kinematics problem. Particular solutions for the inverse kinematics problem - two – axis planar mechanisms. (4 hours)
Autonomous mobile robots: Introduction, locomotion - key issues for locomotion, legged mobile robots, leg configurations & stability , examples of legged robot locomotion. Case studies. (4 hours)

TEXT / REFERENCES:

- Yoram Koren, (1992), Robotics, McGraw Hill
- Janakiraman P.A., (1995), Robotics and image processing, Tata McGraw Hill.
- Groover M.P., (1995), Cam and Automation, Prentice Hall.
- Yu Kozyhev, (1985), Industrial Robots Handbook, MIR Pub.
- Jain K.C., Aggarwal L.N, (1997) Robotics Principles and Practice, Khanna Publishers.

SEMESTER - V

PROJECT WORK

IMET 351 **0-0-36-12**

Students need to form batches with maximum four in numbers and required to identify the problem in their area of interest within their discipline of study under the supervision of a faculty (Guide) for 12 to 14 weeks. At the end, the findings need to be presented in the form of a project report for final evaluation.

SEMESTER - VI

MICRO ELECTRO MECHANICAL SYSTEMS

IMET 361 **4-0-0-4**

Introduction to MEMS and Microsystems: Products, Evolution of micro-fabrication, microelectronics, miniaturization, application in the automotive and other industries. (2 hours)

Working principles of Microsystems: Microsensors – Acoustic wave sensors, Bio-medical sensors and bio sensors, Chemical sensors, Optical sensors, Pressure sensors, Thermal sensors. Microactuation – By thermal forces, Shape memory alloys, piezoelectric crystals and Electrostatic forces, MEMS with Micro actuators, Micro accelerometers, Microfluidics, Problems. (5 hours)
Scaling laws in miniaturization: Scaling in geometry, Scaling in rigid body dynamics, Scaling in electrostatic, electromagnetic forces, Scaling in electricity, Scaling in heat transfer and fluid mechanics. (4 hours)
Materials for MEMS and microsystems: Substrates and wafers, Silicon as a substrate material, silicon compounds, silicon piezo-resistors, Gallium arsenide, Quartz, Polymers, Packaging materials, Problems. (5hours)
Microsystems fabrication Processes: Photo lithography, Ion implantation, Diffusion, Oxidation, Chemical vapor deposition, Physical vapor deposition, Deposition by Epitaxy, Etching, Problems. (6 hours)
Micro-manufacturing: Bulk manufacturing, Surface micromachining, LIGA process. (5 hours)

Microsystems Design: Design consideration, Process design, Mechanical design, Design of a silicon die, Design of microfluidic Network system. Problems (5 hours)
Microsystems Packaging: Mechanical packaging of microelectronics, Microsystems packaging, Interfaces in microsystems packaging, packaging technologies, 3 Dimensional packaging, Assembly of microsystems, Packaging materials, Signal mapping and transduction. (4 hours)

TEXT / REFERENCES:

- Tai Ran Hsu, "MEMS and Microsystems- Design and Manufacturing" TATA McGraw Hill.
- Marc J. Madou (2002) Fundamentals of Micro fabrication: The Science of Miniaturization", CRC Press.
- Wolfgang Menz, J. Mohr, Oliver Paul, (2001) "Microsystem Technology", Wiley-VCH.
- Mohamed Gad-el-Hak, "The MEMS Handbook" (2002), CRC Press.

ELECTRIC DRIVES

IMET 362 **4-0-3-5**

Introduction to Power Electronics- Power flow control switching, power electronic devices – power MOSFET and Power BJT , SCR – V-I , turn on, turn off characteristics, triggering methods, PWM methods, rectifiers – single phase – fully, half and semi controlled, half wave and full wave, full wave rectifier – RL loads, RLE loads with freewheeling diodes. (10 hours)

DC motors – Principle of operation, EMF equation, Types of motors, DC – series, shunt, separately excited, compound, basic equations, motor constants, torque speed characteristics, starting – conventional starters & soft starters, braking – regenerative and dynamic braking, speed control concepts, solid state motor drivers – choppers – buck, boost, buck-boost, single phase thyristor controlled rectifier – RLE load. (10 hours)

Induction Motors – three phase motors, Principle of operation, Types of motors, slip ring , squirrel cage, basic equations, torque speed characteristics, starting – conventional starters, soft starters, braking – regenerative and dynamic braking, speed control- v/f control concepts, solid state motor drivers – ac voltage regulators, inverters - VSI, CSI. Single phase induction motors- types, torque speed characteristics, Synchronous motors. (15 hours)
Motors in automation – Linear Induction motors , PM Synchronous motors - Servo motors, Switched reluctance motors, BLDC motors, stepper motor – types , Universal motor, torque motor, - construction, torque- speed characteristics, applications, merits and demerits. (8 hours)

Fundamental of motor- load interactions – Basic Components of electric drive, Advantages of electric drives, Closed loop speed control, speed – torque conventions, multi-quadrant operation of electric drives, Steady state equilibrium, equivalent moment of inertia, Determination of motor power rating, (5 hours)

TEXT / REFERENCES:

- Shepherd W. and Hully L. N., "Power electronics and motor control", 2/e, Cambridge University, 1995.
- Gopal K. Dubbey "Fundamentals of electric drives", 2/e, Narosa Publishers, 2001.
- Nagrath I.J. and Kothari D.P., "Electric machines", 3/e, Tata McGraw Hill, 2001.
- Bimbra P.S., "Power electronics", 3/e, Khanna Publishers, 2003.

ELECTIVE – I & ELECTIVE – II

IMET 363 & IMET 364 **3-0-0-3**

AUTOMOBILE ENGINEERING:

Introduction: Automotive Engine classification, Multi Cylinder Arrangements. (1 hour)

Automotive Engine Parts:Cylinder Block, cylinder head, crank case, oil pan, cylinder liners, piston, arrangements to control piston slap, piston rings, connecting rod, crank shaft, valves and valve operating mechanisms, valve timing diagram. (3 hours)

Fuel Supply System:Fuel pumps for petrol engines, mixture strength requirements of S I engine, defects of simple carburetor and their remedies, types of carburetors, constant choke and constant vacuum carburetors. (3 hours)

Ignition System:Battery ignition system, Ignition advance methods, comparison between battery and magnetic ignition system. (2 hours)
Cooling System:Necessity, Methods of engine cooling. (2 hours)
Lubrication System:Objects of lubrication, systems of engine lubrication, crankcase ventilation. (2 hours)
Clutch & Gear Box:Clutches- Purpose and requirements, single plate clutch, multiplate clutch, centrifugal clutch, fluid flywheel. Gear box - Purpose, sliding mesh, gear box, constant mesh, gear box, synchromesh gear box, Epicyclic gear box & torque converter.Calculation for torque transmitted by plate and cone clutch, power for propulsion of the vehicles, road resistance & tractive effort, relation between vehicle speed and gear ratio. (8 hours)
Drive To Wheels:Propeller shaft and differential. (1hour)
Steering System:Steering geometry, steering mechanism, steering linkages for rigid axle & Independent suspension systems. Numerical problems related to conditions for pure rolling, turning circle radius. (4 hours)
Suspension System:Objects, types of suspension springs, leaf springs, coil spring & torsion bar. Independent front suspension, telescopic type shock absorber. (2 hours)

Automobile Tyres:Desirable tyre properties, conventional tubed & tubeless tyre. (1 hour)

Brakes: Braking requirements, brake efficiency & stopping distance, fading of brakes, Types of Brakes: Drum and disc brakes, mechanical brakes, hydraulic brakes, servo brakes, air brakes, balance beam compensator.Numerical problems related to brake torque & minimum stopping distance with front wheel, rear wheel & four wheel braking, weight transfer & heat dissipation. (5 hours)
Electrical system: Lighting circuit for an automobile. Starting system – bendix drive. Generator. (2 hours)

TEXT / REFERENCES:

- Heldt.P.M., “High Speed Combustion Engines”, Oxford and IBM Publishers Co. 1985.
- Newton and steeds, “The Motor Vehicle”, ELBS, 1980.
- Kirpal Singh, “Automobile Engineering Vol. I & II”, Standard Publishers Distributors, 1997.
- Narang G.B.S., “Automobile Engineering", Khanna Publishers, 1990.

AUTOMOTIVE COMPONENT DESIGN:

IC engine piston, IC engine cylinder, IC engine connecting rod, Valve gear mechanism. Tappets and Valve train. Engine crank shaft: overhung and center type. Fly wheel Design. Manual and automatic gear box. Shifting mechanisms. Startup device clutch. Differential and final drives. Bearings for throttle body motor. Design of suspension system and their control. Chasis structure design.

TEXT / REFERENCES:

- Shigley J.E., Mischke C.R., "Mechanical Engineering Design" Tata Mc Graw Hill publications.
- Bhandari V., "Machine design", Tata McGraw Hill publication,
- Jain R.K., "Machine design", Khanna Publishers, New Delhi, 1997.
- Sharma P.C. and Aggarwal D.K., "Machine design", S.K.Kataria & sons, 2003
- Kolchin A. and Demidov V., "Design of automotive engines", MIR Publishers, Moscow, 1984.

AUTOTRONICS:

Fundamentals of Automotive Electronics, Current trend in Automobiles, Open loop and closed loop systems, Components for electronic engine management, Parameters to be controlled in SI and CI engines. (3 hours)

Sensors & Actuators:Introduction, basic sensor arrangement, types of sensors Hall Effect, hot wire, thermistor, piezo electric, piezoresistive, based sensors, oxygen concentration sensor, lambda sensor, crankshaft angular position sensor, cam position sensor, Mass air flow (MAF) rate, Manifold absolute pressure (MAP), Throttle plate angular position, engine oil pressure sensor, vehicle speed sensor, stepper motors, relays, detonation sensor, emission sensors. (6 hours)

Digital Engine Control System: Open loop and close loop control system, engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control. (6 hours)

SI Engine Management: Working of the fuel system components, Feedback carburetor system, throttle body injection and multi point fuel injection system, injection system controls Layout and working of SI engine management systems like Bosch Monojetronic, L-Jetronic and LH-Jetronic, Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control, Advantages of electronic ignition system, three way catalytic converter. (7 hours)

CI Engine Management: Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve control in electronically controlled systems. (8 hours)

Vehicle Motion Control and Stabilization Systems: Control of gear shift, types of actuators and torque converter, Electronic steering, Electronic controlled steering system, Electronic clutch, Vehicle motion control - Adaptive cruise control, Electronic transmission control. Vehicle stabilization system - Antilock braking system, Traction control system, Electronic stability program. Electronic dash board instruments – Onboard diagnosis system, Future automotive electronic systems. (6 hours)

TEXT / REFERENCES:

- Young, Griffitns, "Automobile electrical & electronic equipments", Butterworths, London, 2010.

- Wiliam B. Ribbens," Understanding automotive electronics", 5/e, Newnes, Butterworth–Heinemann, 2009.
- Robert Bosch, "Diesel engine management", SAE Publications, 3/e, 2004.
- Robert Bosch , Gasoline engine management",SAE Publications, 2/e, 2004.
- Robert Bosch GmbH, "Automotive electrics and automotive electronics", John Wiley and Sons ,2008.

HYBRID AND ELECTRIC VEHICLES:

Vehicle dynamics : Vehicle Resistance - Rolling Resistance, Aerodynamic Drag, Grading Resistance- Dynamic Equation, Tire–Ground Adhesion and Maximum Tractive Effort, Power Train Tractive Effort and Vehicle Speed, Vehicle Power Plant and Transmission Characteristics, Vehicle Performance- Maximum Speed of a Vehicle, Gradeability, Acceleration Performance. Internal Combustion Engines: Operating Principles -Operation Parameters- Rating Values of Engines, Pressure, Specific Fuel Consumption and Efficiency, Specific Emissions, Fuel/Air and Air/Fuel Ratio, Engine Performance Parameters. (10 hours)

Hybrid and Electric Drive-trains: Configurations of Electric Vehicles, Performance of Electric Vehicles Traction Motor Characteristics, Tractive Effort and Transmission Requirement, Vehicle Performance, Basic concept of hybrid traction, hybrid drive-train architecture – series, parallel – torque and speed coupling, power flow control in hybrid drive-train topologies, fuel efficiency analysis. (8 hours)

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Different motors – DC motors, Induction motors, PMDC, Switched reluctance motors, Configuration and control of Motor drives, power modulators, Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Control and Regenerative breaking: Different Electronic control Unit, Energy Management Strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies, fundamentals of regenerative braking. (8 hours)

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems- Design of Series Hybrid Drive Train. (6 hours)

Fuel Cell Vehicles – Introduction to Fuel Cell Technology, Configuration, Control Strategy , Motor Power Design , Power Design of the Fuel Cell System, Design of the Power and Energy Capacity of the PPS, Design Example (4 hours)

TEXT / REFERENCES:

- Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2/e, CRC Press, 2010.
- Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", 2/e, CRC Press, 2010.
- A. E. Fuhs, "Hybrid Vehicles and the Future of Personal Transportation" ,1/e, CRC Press, 2009.

INTELLIGENT CONTROLLERS:

Fundamentals: Fundamentals of Artificial Neural Networks, McCulloch – Pitts model, Activation functions, Feed forward and feedback networks, learning rules – Hebbian, Perceptron, delta, Widrow-Hoff, winner take all.

Single layer feed forward networks: Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications.

Multi layer feed forward networks: Generalized Delta Rule, Derivation of Back propagation (BP) Training, Summary of Back propagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.

Application: Application of neural networks: Control applications, Character recognition

Fuzzy control: Introduction to Fuzzy control, classical sets & fuzzy sets, fuzzy set operations, Fuzzy relations, membership function, extension principles. Linguistic variables, Fuzzy IF_THEN statements, Inference rules.

Fuzzy Logic System Components: Fuzzification, Membership Value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

Application of fuzzy logic: control applications.(case study)

Introduction to Genetic Algorithm (GA): Principles, Working operation, Design, Applications in control system.

Introduction of hybrid system: fuzzy-neural systems.(options neuro-fuzzy,neuro-genetic,and fuzzy genetics),Familiarization with MATLAB Fuzzy logic & neural network Toolbox.

TEXT / REFERENCES:

- Jacek M. Zurada," Introduction to artificial neural networks", Jaico, 1997.
- Timothy J. Ross," Fuzzy logic with engineering applications", MGH, 1997.
- Chin-Teng-Lin, C. S. George Lee, "Neural fuzzy systems", PHI, 1996.
- Rajasekharan and Rai,"Neural networks, fuzzy logic, genetic algorithms: synthesis and applications", PHI Publication
- MATLAB toolbox (fuzzy and neural network)

MACHINE VISION AND IMAGE PROCESSING:

Image Acquisition and Analysis: Vision and image sensors, digitization, preprocessing, Vision system components, Basic optics, Basic Radiometry, Image formats, Image Noise, Image Representation, Color Space, conversion of color spaces. Image enhancement, operations on images, noise removal, Segmentation, Thresholding, Edge Detection Algorithms, morphological Operations, image analysis coding and representation of regions, dimensional analysis, Feature extraction Fourier transformations, spatial domain techniques. (12 hours)

3D Vision: Perspective Projection Geometry, Pinhole camera model, lens distortion, Affine and Metric Geometry, 2D and 3D Geometrical Transformations, Intrinsic and Extrinsic Camera Parameters, Calibration methods, Stereovision, Epipolar Geometry, triangulation, Rotational

Matrix, Fundamental Matrix, Stereo correspondence Algorithms – Feature Based and Correlation Based, 3D Reconstruction. (12 hours)
Motion Estimation and Tracking: Optical flow estimation, Object tracking with Kalman filtering, Feature Extraction & Object recognition. (6 hours)

Case Studies/Application: Face recognition, Vehicle tracking, Computer Vision Toolbox, MATLAB Examples. (6 hours)

TEXT / REFERENCES:

- Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis and Machine Vision", 2nd Edition, 1998.
- Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 2nd Edition, Pearson Education, 2003.
- Boguslaw Cyganek & J. Paul Siebert, "An Introduction to 3D Computer Vision Techniques and Algorithms", Wiley, 2009
- E.R. Davies, Royal Holloway, "Machine Vision: Theory, Algorithms and Practicalities", Third Edition, University of London, December 2004.

ROBOT DYNAMICS AND CONTROL:

Robot Dynamics- Lagrange-Euler Dynamics, Force, Inertia, and Energy, Lagrange's Equations of Motion, Newton's equations of motion, Formulation of robot dynamics, State-Variable Representations, Dynamics of robots with actuators.
Robot control problems – Regulator problem, tracking problem, controllers -PD, PID compensation, closed loop control, gain tuning, performance analysis, simulation analysis. Set point Tracking – using PD and Feed forward Control, Torque control, Computed torque control , Discretization of Outer PD/PID Control Loop, Actuator Saturation, Integrator Anti-windup Compensation, Quadratic Optimal control problem.
Nonlinear dynamics and control – Lyapunov stability theorem, Robust control, Feedback-Linearization Controllers, Lyapunov Designs, Variable-Structure Controllers , Saturation-Type Controllers. Inverse dynamics controllers, Force control, stiffness control, Impedance control, Hybrid Position/Force Control, Reduced state modeling and control

TEXT / REFERENCES:

- Frank L. Lewis, "Robot Manipulator Control- Theory and Practice", 2/e, CRC Press, 2003
- Mark W. Spong, "Robot Dynamics and Control", 2/e, John Wiley and sons, 2009.
- Yoshikawa, "Foundations Of Robotics: Analysis & Control", 1/e, Prentice Hall India, 2009.

ROBOTIC PATH PLANNING:

Configuration Space – Obstacles space, dimensions of configuration space, topology of configuration space – homeomorphism and diffeomorphism, parameterization, transformations, example configuration space. Potential Functions – obstacle avoidance- additive and repulsive functions, gradient descent. Implementation in plane- computation, local minima problem, navigational potential functions, Non Euclidean potential functions, rigid body robots.
(10 hours)

Algorithms – Analysis and complexity, running time, complexity, completeness. Visibility graph, Graph Search A*, Weighted A*, Anytime & Incremental Search (ARA*/D* Lite/Anytime D*), Real-time search (LRTA* and RTAA*), Road Maps - Generalized Voronoi Graph (GVG) - definition, properties, preimage theorem and critical points, GVG – transversality, connectivity, opportunist path planning. (6 hours)

Cell Decompostion – Trapezoidal decomposition, Morse cell decomposition – variable slice, sensor based coverage, complexity coverage, Visibility based decomposition. Sampling Based Algorithms – Probabilistic Road Map (PRM) – definition, sampling, connection strategies, Single query sampling planners, Rapidly Exploring Random Trees (ERT), Control based planning, Manipulation planning, Optimal motion planning, Feedback motion planning, Randomised Kinodynamic Planning, RRT, RRG, RRT*, RRTs (12 hours)

Motion Planning – Motion planning under kinematics and dynamic constraints, Trajectory planning – Decoupled trajectory planning, Direct trajectory planning, Non-holonomic constraints, Path planning, Combined path planning and control (8 hours)

TEXT / REFERENCES:

- H. Choset, K. M. Lynch, "Principles of Robot Motion: Theory, Algorithms, and Implementations", 1/e, MIT Press, Boston, 2005.
- Planning Algorithms, "Steven M. LaValle", 1/e, Cambridge University Press, 2006.
- Farbod Fahimi –"Autonomous Robots- Modeling, Path Planning, and Control", 1/e Springer, 2009.

ELECTIVE – III & ELECTIVE – IV

IMET 365 & IMET 366 3-0-0-3

ADDITIVE MANUFACTURING TECHNOLOGIES:

Introduction : Introduction to Rapid Manufacturing, Customization and Mass Customization, Classification of Rapid Manufacturing Processes (Additive/Subtractive/Formative), Process Chain for Additive and Other Rapid Manufacturing Processes ,Fundamental automated processes, 3D modeling ,Data conversion and Transmission ,Checking and preparing, Building, Post processing (6 hours)

Data Generation : STL Format, Data Formats for additive and Other Rapid Manufacturing Processes and associated details, STL file problems, consequence of building a valid and invalid tessellated model, STL file repair, other translators, Slicing Algorithms and related details, Newly proposed formats ,Data Conversion for Layered/additive manufacturing and Associated Difficulties, Data Validity Checks and Data repair procedures for Layered Manufacturing, Part Deposition Orientation and its Importance Direct Slicing. (6 hours)

Liquid based RP processes : Stereolithography apparatus (SLA),Solid ground curing (SGC), Solid creation system(SCS) Solid object Ultraviolet laser printer(SOUP),Soliform systems, other similar commercial RP Systems, Rapid freeze prototyping. (5 hours)

Powder based RP processes : Selective laser sintering (SLS),EOSINT systems,Three-Dimensional printing(3DP),Laser engineered Net shaping (LENS),Direct shell production casting(DSPC),Multiphase jet solidification(MJS),Electron beam melting(EBM). (4 hours)

Solid based RP processes :Laminated object manufacturing(LOM),Fused deposition modeling (FDM), Paper lamination technology(PLT),Multi-jet modeling system (MJM),Modelmaker and Patternmaster,Slicing solid manufacturing(SSM), Melted Extrusion Modeling (MEM), Multi-functional RPM system. (4 hours)

Rapid tooling : Indirect and direct rapid tool production,Role of Indirect methods in tool production ,Metal deposition tools, epoxy tools,RTV tools, ceramic cast metal, Investment casting ,Fusible metallic core sand casting. (4 hours)
Other Rapid Manufacturing Processes :Silicon Rubber Moulding, Metal Arc Spray System and other RT processes,Subtractive type, formative type. (3 hours)
Application : Rapid manufacturing process selection,Application and case studies,Application in design, engineering, analysis and planning,Application in manufacturing and tooling, automotive, biomedical industry,Application in jewelry, coin industry. (4 hours)

TEXT / REFERENCES:

- Gibson, I, Rosen, D W., and Stucker, B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
- Hopkinson, N, Haque, R., and Dickens, P., Rapid Manufacturing: An Industrial Revolution for a Digital Age: An Industrial Revolution for the Digital Age, Wiley, 2005.
- Bartolo, P J (editor), Virtual and Rapid Manufacturing: Advanced Research in Virtual and Rapid Prototyping, Taylor and Francis, 2007.
- Chua, C K, Leong, KF., Lim CS, Rapid Prototyping, World Scientific, 2003.
- Pique, A., Chrisey, DB., Direct Write Technologies for RP Applications: Sensors, Electronics and Integrated Power Sourses, Academic Press, 2002.
- Venuvinod, PK., Ma, W., Rapid Prototyping ââ,¬â€œ Laser Based and Othr Technologies, Kluwer, 2004.

COMPUTER NETWORKING & COMMUNICATION PROTOCOL:

Introduction to Reference Models: Introduction to data communication, Network architecture, Basics of OSI and TCP/IP reference models. (4 hours)

Transmission Media: Wired and wireless connectivity, FDM, TDM and CDMA, Circuit and packet switching. Frame relay and ATM switching, ISDN, Local area network protocols, IEEE standards for LAN, Satellite networks. (7 hours)

Data link layer design issues: its functions and protocols, link layer: error detection and correction techniques, Multiple access protocol, Ethernet, hubs and switches, PPP. (4 hours)
Network layer: Protocol and Packet format: Internet protocol, IPv6, Routing algorithms, IP addressing schemes, Internetworking and sub-netting. Transport layer: connectionless transport-UDP, principles of reliable data transfer, congestion control algorithm. Application layer design issues: FTP, Electronic Mail in the Internet, P2P file sharing, HTTP (12 hours)

Quality of Services: ATM, Differentiated services Model, Flow identification, Scheduling, Factors affecting QOS parameters and service categories. QOS classes, (5 hours)

Network Management: Network Management protocol, SNMP, CMIP, Issues in the management of large networks, Concept of Traffic and service. voice and video data, ATM Traffic, Elements of ATM Traffic management-Traffic contracting. (4 hours)

TEXT / REFERENCES:

- James F. Kurose, Keith W. Ross – " Computer Networking (A Top-Down Approach Featuring the Internet) 3rd edition, 2005 , Pearson Education.
- Andrew S. Tanenbaum – "Computer Networks, 5th Edition, 2010, Prentice Hall of India Pvt. Ltd.

- Charle Kaufman, Radia Perlman, Mike Specines, Uyless Black "Computer Networks: Protocols Standards and Interfaces " PHI.
- William Stallings – Data and Computer Communications, 7th Edition, 2004, Prentice Hall of India Pvt. Ltd.

DATABASE MANAGEMENT SYSTEMS:

Introduction : Database-System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Data Storage and Querying, Transaction Management, Database Architecture, Database Users and Administrators. (4 hours)

Relational Model: Structure of Relational Databases, Database Schemas, Keys, Relational Query Languages, Relational Operations. (2 hours)

Database Design and The E-R Model: Overview of the Design Process, The Entity-Relationship Model, Constraints, Removing Redundant Attributes in Entity Sets, Entity-Relationship Diagrams, Entity-Relationship Design Issues, Extended E-R Features,Reduction to Relational Schemas. (4 hours)

SQL: SQL Data Definition, SQL Data Types and Schemas, Integrity Constraints, Basic Structure of SQL Queries, Set Operations, Aggregate Functions, Nested Subqueries, Additional Basic Operations Null Values, Modification of the Database. (6 hours)

Relational Database Design: Features of Good Relational Design, Atomic Domains and First Normal Form, Decomposition Using Functional Dependencies, Functional Dependency Theory, Algorithms for Decomposition, Decomposition Using Multivalued Dependencies. (4 hours)

Transaction Management: Transaction Concept, A simple Transaction model, Storage Structure, Transaction Atomicity and Durability, Transaction isolation, Serializability. (2 hours)

Data mining: Introduction, Association rules mining, market based analysis, Apriori Algorithm, Partition Algorithm, Pincer – Search Algorithm, Dynamic item set counting algorithm, FP-tree growth Algorithm, PC Tree, Multilevel association rules, Approaches to mining multilevel association rules, correlation analysis, Issues and challenges in Data mining. (8 hours)

Clustering Techniques: Introduction, Clustering paradigms, Partitioning Algorithms, k – Medoid & k- means Algorithms, CLARA, CLARANS, Hierarchical Clustering, DBSCAN. (3 hours)

Classification and Prediction: Introduction, Tree Construction principle, Best Split, Splitting Indices, Splitting Criteria, Decision Tree Construction Algorithm, Tree pruning. (3 hours)

TEXT / REFERENCES:

- Silberschatz, Korth, Sudarshan, "Database System Concepts", 6th Edition, McGrawHill, New York, 2011.
- RamezElmasri and ShamkantNavathe, Durvasula V L N Somayajulu, Shyam K Gupta, "Fundamentals of Database Systems", 6th Edition, Pearson Education, United States of America,2011.
- Thomas Connolly, Carolyn Begg, "Database Systems – A Practical Approach to Design, Implementation and Management", 4th Edition,Pearson Education, England, 2005.
- Peter Rob, Carlos Coronel, "Database Systems–Design, Implementation and Management",10th Edition, Course Technology, Boston , 2013.
- Jiawei Han and Micheline Kamber, " Data Mining Concepts And Techniques", Morgan Kauffmann Publishers, 2nd Edition, , 2008
- Arun K Pujari, " Data Mining Techniques", , Universities Press India, 1st Edition, 2001.

DESIGN OF MECHANICAL DRIVES:

Gears: Bevel Gears - nomenclature, straight teeth bevel gears, cone angle, virtual number of teeth, face width, gear tooth force analysis, static strength, dynamic strength, wear strength. Worm Gears - nomenclature, materials, reversibility, mechanical advantage, gear tooth force analysis, strength design, efficiency, heat dissipation. (10 hours)

Sliding Contact Bearings: Journal bearings, bearing modulus, sommerfeld number, coefficient of friction, mechanism of film lubrication, eccentricity and minimum oil film thickness, temperature rise, oil flow, heat generation & dissipation. (5 hours)

Belt Drives: Power transmission, flat and V- belts, ratio of belt tensions, centrifugal tension, power rating, V-flat drives, pulleys, selection of belts and pulleys. (3 hours)

Wire Rope Drives: Types & construction of wire ropes, loads & stresses in ropes, selection of wire ropes. (2 hours)
Chain Drives: Types of power chains, chordal action, sprocket size & teeth, chain speed, Selection of roller chains. (2 hours)
Mechanical Brakes: Block brakes, Band brakes, Pivoted shoe brakes, disc brakes, torque capacity, heat dissipation. (6 hours)
Miscellaneous Topics: Levers, seals, case studies involving field visit and making a design and report on the actual machineries. (8 hours)

TEXT / REFERENCES:

- Shigley J. E. and Mischke C. R., "Mechanical Engineering Design", 5/e, McGraw Hill Inc, New York, 2004
- Bhandari V. B., Design of Machine Elements, 2/e, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007
- Norton R. L., "Machine Design - An Integrated Approach", 2/e, Prentice Hall Inc. New Jersy, 2004
- Juvenile R. C. and Marshek K. M., "Fundamentals of Machine Component Design", 3/e, John Wiley and Sons, Inc, New York, 2000.
- Mahadevan K. and Balaveera Reddy K., "Machine Design Data Hand Book", 4/e, CBS Publishers and distributors, New Delhi, 2014

DYNAMICS AND CONTROL OF MECHATRONICS SYSTEMS:

Industrial Feedback controllers – Performance indices, PID controllers, tuning – Ziegler – Nicholas Tuning Methods, Design of PID controllers – Frequency Response Approach, Computational optimization, Modified PID scheme, Two degrees of freedom control, Zero placement Approach. (6 hours)

Introduction to State Space Analysis - State space representations - Canonical form, observable forms, diagonal form , Jordan form, eigen vectors and eigen values, invariance of eigen values, state space formulation of transfer functions, state space modeling of physical systems - inverted pendulum, ball and beam system, cruise control, armature controlled DC motor, vehicle suspension system (linear systems) (10 hours)

Control System Design in state space : Solution of LTI state equation, Controllability and Observability, Pole placement methods, state feedback controllers, methods to determine gain matrix K, state observers - full order, methods to determine observer gain matrix Ke, Design of

regulator systems with observers (2nd order systems). Lyapunov stability analysis, Linear quadratic optimal control– inverted pendulum, suspension systems- case study. (10 hours)
Non – Linear Systems: Types of nonlinearity - dead zone, saturation, hysteresis, jump resonance, backlash. Describing functions - saturation, dead zone, phase plane method, linearization techniques – Taylor series expansion, feedback linearization techniques – upto 2nd order systems. Case study – Nonlinear modeling of cruise control- linearization. (6 hours)
Matlab and Simulink – Matlab based examples of state space modeling, feedback controllers, observers, regulator problems. (4 hours)

TEXT / REFERENCES:

- Ogata K. , "Modern Control Engineering", 5/e, Pearson Prentice Hall,2005.
- Karl J. Astrom' " Feedback systems : An introduction for scientists and engineers", Princeton University Press, 2008.
- Norman S. Nise , " Control Systems Engineering", 6/e, John Wiley & Sons, Inc, 2011.
- Stanley M. Shinners, " Modern Control systems, Theory and Design", John Wiley & Sons, Inc, 2009.
- Gopal M.," Modern Control System Theory", 2/e, New Age International Ltd, 2005.

FPGA BASED DIGITAL SYSTEM DESIGN:

Hardware Description Language: Digital system design methodologies, hardware and software implementation options. Introduction to HDL languages, Xilinx ISE tool. Logic design with Verilog HDL: Structural, dataflow and Behavioral models of combinational and sequential logic, hierarchical modeling, test benches, logic simulation using Xilinx toolset, coding examples. (18 hours)

Design options for digital systems: Digital System implementation using MSI/LSI circuits like PAL, PLA, Programmable ASICs – PLDs, CPLDs, MPGAs and FPGAs.
FPGA Architectures: ACTEL, XILINX and ALTERA logic families, logic module, switching technology, I/O cells, Programmable interconnect. (10 hours)

Design for testability: Faults, testing combinational and sequential logic, Boundary scan. Synthesis and implementation. Case studies. (8 hours)

TEXT / REFERENCES:

- Ming-Bo Lin,"Digital design and practices using Veriliog HDL and FPGA",Wiley, 2008
- M.J.S.Smith,"Application Specific ICs", Pearson, 1997.
- Wakerly J. F.,"Digital Design Principles & Practices", Pearson, 2001
- W.Wolf," FPGA based system design", Pearson, 2004
- Michael D. Ciletti," Advanced digital system design with Verilog HDL", 2011

INTRODUCTION TO ALGORITHMS:

Introduction: Introduction, Fundamentals of Algorithmic Problem Solving, Important Problem Types, Fundamental Data Structures.

Fundamentals Of The Analysis Of Algorithm Efficiency: Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Nonrecursive and Recursive Algorithms.

Brute Force: Selection Sort and Bubble Sort, Sequential Search and Brute-Force String Matching, Exhaustive Search Method, Depth First Search, Breadth First Search.

Decrease And Conquer: Insertion Sort, Topological Sorting, Algorithms for Generating Combinatorial Objects.

Divide And Conquer: Mergesort, Quicksort, Binary Tree Traversals and Related Properties

Transform And Conquer:Presorting, Balanced Search Trees, Heaps and Heapsort, Problem Reduction

Space And Time Tradeoffs: Sorting by Counting, Input Enhancement in String Matching, Hashing.

Dynamic programming: Dynamic Programming Examples, Warshall's and Floyd's Algorithms,The Knapsack Problem.

Greedy technique: Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees

TEXT / REFERENCES:

- Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, India, 2012.
- Ellis Horowitz, Sartaj Sahni and Sangutherav Rajasekaran, "Computer Algorithms/C++", Second Edition, University Press, 2007.
- Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, "Introduction to Algorithms", 2nd Edition, PHI, India, 2006.

MACHINE TOOL TECHNOLOGY:

Introduction: Elementary treatment of metal cutting theory, element of cutting process, Cutting Tools Classification, Nomenclature of single point cutting tool, geometry of single point tool angles, chip formation and types of chips, built up edge and its effects chip breakers, mechanics of orthogonal cutting, Forces acting on a tool, Merchant's force diagram, Velocity relations, specific energy in cutting, cutting forces, cutting speeds, feed, depth of cut, Lathe tool Dynamometer. (10 hours)

Tool Wear: Tool Wear, Tool life Factors affecting tool life, Taylor's Tool life Equation, Tool wear mechanisms, Types of tool wear, Heat distribution in metal cutting, Measurement of temperature in metal cutting. (8 hours)

Cutting Tool Materials: Requirements of tool materials, advances in tool materials, HSS, Coated HSS, Carbides ,Coated Carbides, Ceramics, Cold pressed, Hot Pressed , Ceramic Composites, CBN, Diamond- properties, Advantages and Limitations, Specifications for Inserts and tool holders. (6 hours)

CNC Tooling: Turning tool geometry, Milling tooling systems, types of motion controls in CNC machines, Tool presetting, automated tool & pallet changing, work holding devices, cutting process parameter selection. (6 hours)

JIGS & FIXTURES: Principles of design of jigs and fixtures and uses, classification of jigs & fixtures, principles of location, Locating devices, 3-2-1 principle of location pin location: Radial

location, 'V' location, Diamond locators, types of clamping & work holding devices, typical examples of jigs and fixtures (6 hours)

TEXT / REFERENCES:

- Milton C.Shaw, "Metal cutting principles", 2/e, Oxford University Press, 2000.
- Kempster," Jigs and fixtures" , 2/e, Mark Howard Publications, 1974.
- Sharma. P. C, "A text book of production engineering", 7/e, SChand Publishers, New Delhi, 2008.
- Juneja and Nitin Seth, "Fundamental of metal cutting and machine tools", 2/e, New Age International Publishers, 2003.

MECHANICAL VIBRATIONS:

Introduction to mechanical vibration, vibration system and types, vibration analysis - degrees of freedom, mathematical modeling, equations of motion, SHM, natural frequency of single degree of freedom system – mathematical modeling, derivation of governing differential equation of motion for free undamped and damped systems, forced vibration – single degree of freedom system under harmonic excitation, steady state, reciprocating and rotating unbalance, transmissibility and isolation, base excitation with harmonic input. Two degree of freedom systems - natural frequencies and mode shapes, forced vibration. Natural frequency of multi-degree of freedom systems, vibration control, vibration testing and measurement.

TEXT / REFERENCES:

- Groover G.K., Mechanical Vibrations, Nemchand and Bros, Roorkee, 2012
- Singirisu Rao S, Mechanical Vibration, Pearson Education, Delhi, 2004
- Dukkapatti Rao V., Text Book of Mechanical Vibration. Prentice Hall of India Ltd, 2004.
- Daniel Imnan J. Engineering Vibration, Prentice Hall, New Delhi, 2001
- Thomson W.T., Theory of Vibrations with Applications, Chapman and Hall, 4th Edition, 1993.

MICRO - MANUFACTURING SYSTEMS:

Introduction, working principles and process parameters, machine tools, applications of the micro manufacturing processes, challenges in meso, micro, and nanomanufacturing, industrial applications and future scope of micro-manufacturing processes. Different instruments related to micro manufacturing such as microsensors, microactuators, microsystems. Working principles, machine construction, and applications of micromachining, nanofinishing, microjoining, microforming, microcasting, micromolding, LIGA for micro/nano products and features, the diversified industrial applications of the micro-manufactured processes, and recent research trends in this area.

TEXT / REFERENCES:

- Jain V. K., Introduction to Micromachining, Narosa Publishing house Pvt. Ltd., 2010
- Jain V. K., Micromanufacturing, CRC Press, 2012
- Jain V. K., Advanced Machining Processes, Allied Publishers Pvt. Ltd., 2014
- Mahalik N. P., Micromanufacturing & Nanotechnology, Springer Berlin Heidelberg, 2006
- Jackson J. M., Microfacbrication & Nanomanufacturing, CRC Press, 2005.

NANOTECHNOLOGY:

Introduction to nanotechnology, bottom-up and top-down approaches, physical and chemical properties, methods of preparation of nanoparticles, carbon nanostructures and their applications, physical chemistry of nanosystems, micro electro mechanical devices and technologies - microsensors, MEMS fabrication processes and applications, microscale and nanoscale heat conduction, nanofluids preparation and characterization, nanomaterials used in energy and environmental applications and their properties, future development of micro actuators, nano-lithograghy, photoresist patterning, photolithography, electron beam lithography, production of polygon mirrors, optic fibers, future trends in nanotechnology.

TEXT / REFERENCES:

- Charles P. Poole, Introduction to Nanotechnology, Wiley-Interscience, 2003.
- Guozhong Cao, Nanostructures & Nanomaterials, Imperial College Press, 2004.
- C B Sobhan, Microscale and Nanoscale Heat Transfer, Taylor and Francis, 2008.
- Norio Taniguchi, Nanotechnology, Oxford University Press, 2008.
- James J Allen, MEMS Design, Taylor and Francis, 2005.

NOISE VIBRATION AND HARSHNESS:

Sources of noise and vibration, design features, Marque values, noise quality. Pass-by noise requirements, target vehicles and objective targets, sound measurement, human sensitivity and weighting factors, combining sound sources, acoustical resonances. Properties of acoustic materials, transient and steady state response of one degree of freedom system applied to vehicle systems, transmissibility. Modes of vibration, test facilities and instrumentation, signal processing NVH control strategies, source ranking. Noise path analysis, design of experiments, and optimization of dynamic characteristics. Vibration absorbers and Helmholtz resonators, active control techniques.

TEXT / REFERENCES:

- Norton M P, Fundamental of Noise and Vibration, Cambridge University Press.
- Seto, Mechanical Vibrations, Schaum Outline Series, McGraw Hill Book Company, New York, 1990.
- Springer and Patterson, Engine Emission, Plenum Press 1990.
- Thomson W T, Theory of Vibration with Applications, CBS Publishers and Distributors, New Delhi, 1990.
- Ashok Kumar Mallik, Principles of Vibration control, Affiliated East-West Press (P) Ltd., New Delhi, 1990.

PRINCIPLES OF SOFTWARE ENGINEERING AND TESTING:

Introduction to the software engineering approach and challenges. Software requirements, problem analysis and requirement specifications, functional specification with use cases.

function oriented design principle, module level concepts, design notations and specifications, structured design methodology. Object oriented design, OO analysis and OO design, OO concepts, unified modeling Language. Programming principle, guidelines, coding process. Testing, black box testing, white box testing. Integration testing as a type of testing, and phase of testing, scenario testing, defect bash. Regression testing types, best practices.

TEXT / REFERENCES:

- PankajJalote, An Integrated Approach To Software Engineering,(3/e), Narosa, 2005.
- Srinivasan Desikan, Gopalswamy Ramesh, Software Testing: Principles and Practices, Pearsons publication.
- Rajib Mall, Fundamentals of Software Engineering, (3/e) PHI learning 2009.
- Roger S. Pressman, Software Engineering A Practioner's Approach, (6/e) McGraw-Hill, 2005.
- Ian Sommerville, Software Engineering, (3/e), Pearson, 2010.

PRODUCTION AND OPERATIONS MANAGEMENT:

Introduction, production consumption cycle, forecasting- quantitative and qualitative methods, Forecast control, measures of forecast accuracy product development and design, product life cycle, process design, process charts, flow diagrams and man machine charts capacity planning, breakeven analysis, single and multi-product P-V charts, aggregate planning, trial and error approach, use of transportation algorithm, job shop scheduling, Sequencing of "n" jobs through 2 machines, "n" jobs through 3 machines and 2 jobs through "n" machines inventory management and line balancing, resource conversion and concepts, planning models and behavioural applications, case studies.

TEXT / REFERENCES:

- Adam Everett E. Jr. and Ebert Ronald J. Production and Operations Management, Prentice Hall of India Pvt. Ltd., 2002.
- Chase Richard B., Aquilano Nicholas J. and Jacobs F. Roberts Production and Operations Management, Tata McGraw-Hill publishing Co. Ltd., 1999.
- Eilon Samuel, Elements of Production Planning and Control, Universal Publishing Corporation, 1991.
- Monks Joseph G. Operations Management, Tata McGraw-Hill Publishing Co. Ltd., 2004.
- Krajewski Lee J. and Ritzman Larry P. Operations Management, Pearson Education Pvt. Ltd., 2005.

SYSTEM MODELING AND SIMULATION:

Principles of modeling and simulation, modeling and simulation of mixed systems, transfer function, block diagram, state space representation of SISO, MIMO, modeling of dynamic systems, construction, analysis, practical applications, linear systems, methods of model order determination, impulse and frequency response methods, system identification, algorithms for parameter estimation, gradient algorithm, least square algorithm, ARX, ARMAX applications of LS and ARMA methods, regression methods, introduction to nonlinear modeling, identification NARMAX model, case studies UAV quad-rotor, hard discs, maglev systems, ball and beam systems.

TEXT / REFERENCES:

- George Pelz, Mechatronic Systems Modeling and Simulation with HDLs, Wiley, 2003
- Devdas Shetty, Richard Kolk, Mechatronics System Design, (2e), Cengage Learning, 2010
- Benjamin C. Kuo, Farid Golnarghi, Automatic Control Systems, (8e), Wiley, 2009.
- Jack W. Lewis, Modeling of Engineering Systems PC-Based Techniques and Design Tools, High Text Publications, 2000.
- Ioan D. Landau, Gianluca Zito, Digital Control Systems Design, Identification and Implementation, Springer, 2006.

WIRELESS SENSOR NETWORKSS:

Challenges for wireless sensor networks, single node architecture, hardware components, energy consumption of sensor nodes, network architecture, types of sources and sinks, single hop versus multi-hop networks, multiple sinks and sources, wireless channel and communication fundamentals, frequency allocation, modulation and demodulation, MAC protocols, contention-based protocols, SMAC – BMAC, TRAMA, IEEE 802.15.4 MAC protocol, Q-MAC (Querry MAC), Q-MAC (QoS MAC). Routing challenges and design, SPIN COUGAR, ACQUIRE, LEACH, PEGASIS, GF, GAF, GEAR, Aggregation techniques – TAG, Tiny DB traditional transport control protocols. Wireless LANs: 802.11, 802.11a/b/g, 802.16-WiMAX, UWB communications, wireless personal area networks, BlueTooth. Healthcare monitoring system using wireless sensor networks, remote home lighting and appliance control system, automatic speed control and vehicle tracking using GSM and GPS technologies.

TEXT / REFERENCES:

- Kazem Sohraby, Daniel Minoli and Taieb Znati, Wireless Sensor Networks Technology-Protocols and Applications, John Wiley & Sons, 2007.
- Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons, Ltd, 2005.
- Ananthram Swami, Qing Zhao, Yao-Win Hong, Lang Tong Pub, Wireless Sensor Networks Signal Processing and Communications, John Wiley & Sons.
- Murthy, Ad Hoc Wireless Networks: Architectures and Protocols, Pearson Education.
- Sridhar S. Iyengar, NandanParameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Fundamentals of Sensor Network Programming: Applications and Technology, John Wiley & Sons

MACHINE LEARNING:

Introduction to Machine Learning, Review of Linear Algebra, Review of Probability theory, Overview of Convex optimization, Hidden Markov models, Multivariate Gaussian distribution, Gaussian Processes. Bayesian decision theory, Maximum likelihood ratio, Parametric classification, Regression, Multivariate methods, K-nearest neighbor classification, Supervised learning: Setup, LMS, Logistic regression, Perceptron, Exponential family, Generative learning algorithms, Gaussian discriminant analysis, Naïve Bayes, Support vector machines, Model selection and feature selection, Evaluation and debugging learning algorithms. Unsupervised

learning: Clustering, K-means, Hierarchical clustering, Competitive learning, Radial basis functions. EM, Mixture of Gaussians, Factor analysis, Principal Component Analysis, Independent Component Analysis, Naïve Bayes classifier, Hidden Markov model, Linear Regression, Belief Propagation, Generating diverse learners, Voting, Error correction output codes, Bagging, Boosting.

TEXT / REFERENCES:

- Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
- Ethem Alpaydin, "Introduction to Machine Learning", 2nd edition, MIT Press, 2010.
- Duda and Hast, "Pattern Classification", 2nd edition.
- Mehryar Mohri, Afshin Rostamizadeh and Amet Talwalkar, "Foundation of Machine Learning", MIT Press 2012.
- Daphne Koller and Nir Friedman, "Probabilistic Graphical Models: Principles and Techniques", MIT Press, 2009.
- Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.

SEMINAR

IMET 367 **0-0-3-1**

Students need to present a seminar on a topic of recent developments in their subject filed.

B.Sc. (AERONAUTICAL/AEROSPACE/AVIATION)

II SEMESTER

IMA 121 – MATHEMATICS - II (Refer page no. **33**)

IPH 121 – PHYSICS - II (Refer page no. **33**)

ICH 121 - CHEMISTRY (Refer page no. **35**)

IME 121 – ENGINEERING GRAPHICS - II (Refer page no. **36**)

IME 123 - STRENGTH OF MATERIALS (Refer page no. **155**)

INTRODUCTION TO AEROSPACE ENGINEERING AND AVIONICS

IAV 121 **3-1-0-4**

Fundamental Thoughts of Aerospace Engineering: History of flight, Ballooning, The source of all aerodynamic forces, Equation of state for a perfect gas, specific volume, anatomy of aircraft and spacecraft, Standard Atmosphere and relationship. (8 hours)

Aerodynamics: Basics of Aerodynamics, Standard atmosphere, Incompressible and compressible flow, elementary thermodynamics, laws of conservations, speed of sound, measurement of airspeed. (8 hours)

Aircraft Flight: Airfoil Nomenclature, Lift, Drag and Moment co-efficient, Elements of Airplane Performance – Equation of Motions for level flight, climbing flight, gliding flight, take-off and landing, Stability and Control, Space vehicle, trajectory and launch vehicle. (8 hours)

Introduction to Space flight mechanics: The two-body problem, Earth-satellite operations, rocket performance, space environments, interplanetary trajectories. (5 hours)

Introduction to Avionics: Need for Avionics in Civil and Military Aircraft and Space Systems, Integrated Avionics and Weapon Systems, Typical Avionics Sub-systems Design & Technology, Defining Avionics Systems Requirements. (2 hours)

Avionics Systems Essentials I:-Displays, HMI, I/O Devices: Trends in Display Technology, Alphanumeric Displays, Character Displays etc., Basic Components of Displays, CRT Displays, LCDs etc., and their characteristics, Civil and Military Aircraft Cockpits, MFDs, MFK, HUD, DVI, HOTAS, Helmet Mounted Display, Synthetic and enhanced vision, Situation Awareness, Panoramic/big Picture Display, Virtual Cockpit-Civil and Military Electrical Power Requirement Standards, Comparing the Military and Civil Requirements and Tips for Power System Design. (6 hours)

Aircraft Navigation: Sensors, Inertial Navigation systems, Satellite Navigation System, Automatic Direction Finding (ADF), VHF Omnidirectional Range (VOR), Instrument Landing Systems (ILS), Hyperbolic Navigation Systems (LORAN), Distance Measuring Equipment (DME), Transponders. (8 hours)

Landing Systems & Control:Mechanics of Landing, Automatic landing systems, Instruments Landing Systems, Microwave landing Systems, Satellites landing systems, Carrier landing systems, Surveillance systems-radio altimeter, Flight Control and FMS. (3 hours)

TEXT/ REFERENCES:

- John D. Anderson. Introduction to Flight, 6th edition; ISBN-13: 978-007-126318-4.
- Myron Kayton & Walter R. Fried, "Avionics Navigation Systems, 2nd Edition", Wiley-interscience, [May 1997].
- R.P.G. Collinson, "Introduction to Avionics Systems", Springer, [2002].
- Dava Newman (2001). Interactive Aerospace Engineering and Design; MIT Press
- Cary R. Spitzer, "Digital Avionics Handbook: 2nd Edition, Avionics Development and Implementation", CRC Press, Taylor & Francis Group, [2007].

B.Sc. (ARCHITECTURAL)

I SEMESTER

ARCHITECTURAL DESIGN & DETAILING – STUDIO I

IAE 111 **2-6-0-8**

UNIT I - Theme & Focus of Design: User activity analysis; fundamentals of anthropometric studies & architectural design process; Study of building components; Development of forms through sketches, models; Case studies.

UNIT II - Basic Components: Behavioral Science; Functionality; Building Materials; Theory of Design; Form Development; Tectonic decisions - Structures, Building Materials, Services; Site Planning; Building Control Regulations; Inclusive Design; Design Communication.

UNIT III - Introductory to Anthropometrics: Study of human dimensions; space requirements for human activities; Detailing for human comfort; Furniture details & layouts.

UNIT IV - Study of Building Components: Understanding components in buildings; Purpose; Applications in buildings; Interrelations; Designs; Materials; Innovations.

UNIT V - Design Exercise: Building Design; Complexity - Designing space for single/double user/s; Typology - Kiosk Design such as Security Cabin, Milk Booth, Photocopy Shop, Flower Shop, Gift Shop, Ticket Booth, Book/ Newspaper Stall, Food Stall, etc.; Site extent - Level site upto 100 m^2.

TEXT/ REFERENCES:

- Broomer, F. Gerald. (1974). Elements of Design: Space. Davis Publications Inc., Worcester, Massachusetts.
- Wagenknecht, Kay and Herte. (1989). Site + Sculpture – A collaborated design Process. Van Nostrand Reinhold, NY.
- Ching Francis. (1979). Architecture Form, Space and Order. Van Nostrand Reinhold Company, New York.
- Neufert Ernst. (1970). Architect's Data. Crosby Lockwood and Sons, London.
- Chiara JD and Calender. (1983). Time Savers Standards for Building Type. McGraw Hill Book Company, New York.
- Allen, Edward and Iano, Joseph. (2006). The Architect's Studio Companion: Rules of Thumb for Preliminary Design. Wiley; 4th edition.
- Frederick, Matthew. (2007). 101 Things I Learned in Architecture School. The MIT Press.
- Pearson, David. (2001). New organic architecture: the breaking wave. University of California Press.
- Fawcett, Peter. (2003). Architecture: design notebook. Architectural Press, 2nd edition

STRUCTURAL & CONSTRUCTION SYSTEMS – STUDIO I

IAE 112 2-2-2-5

UNIT I - Introduction: Natural & manmade structures of various forms & their structural behavior; Case studies of ant hill, trees, honey comb, shell structure, membrane structure etc.; Building components & overview of their structural behavior.

UNIT II - Structural Concepts: Force, equilibrium of forces; Load transfer in buildings - load bearing & framed structures; Overview of strength of materials - stress & strain, stress-strain diagrams; elastic constants, structural failure, prevention, factor of safety.

UNIT III - Brick Masonry: Brick bonds, walls, piers, footings; Load bearing & non-load bearing walls; Construction details; Earthquake resistance; Structural concepts.

UNIT IV - Stone Masonry: Types - walls, piers, footings, retaining structures; Construction details; Earthquake resistance; Structural concepts.

UNIT V - Openings: Types & uses; Arches & Lintels - classifications, structural concepts; Construction details using brick & stone.

TEXT/ REFERENCES:

- Bhavikatti, S.S. and Rajashekarappa, K.G. (2012), Engineering Mechanics; New Age International, New Delhi.
- Timoshenko, S and Young, D.H. (1951), Engineering Mechanics; Tata McGraw Hill Publishing company, New delhi.
- Kumar, K.L. (1986), Engineering Mechanics; Tata McGraw Hill Publishing company, New delhi.
- Singer, F.L. (1975), Engineering Mechanics; Harper and Row Publishers, NewYork.
- Ramamrutham, S. (1973), Strength of Materials; DhanpatRai Publications, NewDelhi.
- Timoshenko, S. (1983), Strength of Materials Part 1-2; Krieger Publishing Company, Florida.
- Stephens, R.C. (1970), Strength of Materials Theory and Examples; Edward Arnold Publishers Ltd., London.
- Punmia, B.C. and Goyal, S.C. (1965), Strength of Materials and Theory of Structures; Standard Publishing House, Delhi.
- Singh, G. (1964), Strength of Materials and Structures; Khanna Publishers, New Delhi.
- Punmia, B.C. and Ashok Kumar Jain (2014), Building Construction; Laxmi Publications Pvt. Ltd; New Delhi.
- Chudley Roy and Roger Greeno (1990), Building Construction Handbook; Heinmann Press, Oxford.
- McKay, W.B.(2003), Building Construction; Orient Longman Publishers, Mumbai.
- Markham, J.H. and others (1927), Building Construction; Library Press, London.
- Jaggard Walter R. and Drury Francis, E. (1950), Architectural Building Construction; Cambridge University Press, Cambridge.

- Edward Allen and Joseph Iano (2009), Fundamentals of Building Construction: Materials and Methods; John Wiley & Sons Publishing Company, New Jersey.

ARCHITECTURAL REPRESENTATION – STUDIO - I

IAE 113 **1-1-4-4**

UNIT I - Introduction: Unique features of artistic rendering & architectural rendering. Introduction to points, lines application of line weights, meaning of lines, freehand line exercises architectural lettering, dimensioning, perceiving lines & dots from landscapes & builtscapes, line rendering & dot rendering; Principles of design, compositions & aesthetics.
UNIT II - Understanding of Scale & Proportion in Architecture: Construction of plain scale & diagonal scale; Construction of major conic sections - parabola & ellipse.

UNIT III - Understanding of Compositions : Introduction to quadrant system & conventions of rotations; Projections of points & lines; 2D composition with paper, dots & lines/ collage; Freehand sketching of 2D compositions.

UNIT IV - Understanding of Volumes: Projection of solids -3D compositions modeling; Understanding of human proportion in relation with compositions; freehand sketching of volumes, spaces & human figures; Introduction to isometric & axonometric views.

TEXT/ REFERENCES:

- Bhatt, N D. (2006). Engineering Drawing. Charotar Publishing House, Bangalore, India.
- Gopalakrishna, K R. (2007). Engineering Graphics. Subhas Publications, Bangalore, India.
- Mathur M L, Vaishwanar R S.(2009). Engineering Drawing and Graphics. Jain Brothers, New Delhi
- Venugopal, K. (2005). Engineering Drawing and graphics plus AutoCAD. New Age International , New Delhi
- Gill Robert, W(1990). Manual of Rendering with Pen and Ink; Thames and Hudson Ltd., London.

BUILDING MATERIALS

IAE 114 **1-0-2-2**

UNIT I - Stone & Clay: Stone - Classification of rocks, quarrying of stones, characteristics of a good stone, dressing, uses, deterioration & preservation of stones; Clay - classification, composition, manufacturing, properties, products, qualities of clay bricks, terracotta tiles, & clay blocks.

UNIT II - Cement, Mortar & Concrete: Sand - sources, properties, substitutes for Sand; Lime - composition, classification, physical & chemical properties, uses; Cement - types, composition, manufacturing, properties, qualities & applications; Mortar & Concrete - types, constituents, water-cement ratio, properties, qualities, workability applications.

UNIT III - Timber & Timber Products: Classification of commercial timber in India; Structure of timber; Qualities of good timber, seasoning, defects & decay of timber, preservation; Cut sizes & uses of timber, market forms of timber; Timber products - plywood, particle boards & fiber boards.

UNIT IV - Metals & Metal Products: Ferrous & Non-ferrous metals - types, composition, mechanical & physical properties; Uses; Steel & Alloys - composition, mechanical & physical properties, defects & treatment, market forms of steel; Uses.

UNIT V - Other Materials: Glass & ceramics - types, compositions, physical & mechanical properties; Uses; Polymeric material: different types, compositions, physical & mechanical properties; Uses; Paints & varnish -types, characteristics of an ideal paint; Rubber - classifications, uses in buildings.

TEXT/ REFERENCES:

- McKay, G.B. (1972). Building Construction (Metric). Longman, London.
- Foster, Stroud. (1963). Mitchell's Advanced Building Construction. Allied Publishers Private Limited, Bombay.
- Gurucharan Singh. (1981). Building Construction Engineering. Standard Book House, New Delhi.
- Dr.T.S.Balagopal Prabhu. (1987). Building Drawing and Detailing. Spades Publishers Pvt Ltd Calicut.
- Chudley R. (1998). Construction technology. ELBS, England.
- Ambrose James. (1987). Building construction. Van Nostrand Reinhold, New York
- Rangwala S C. (1998). Engineering materials. Charotar Publishing House, Anand
- Deplazes, Andrea. (2008). Constructing Architecture: Materials, Processes, Structures.
- Birkhäuser Basel.
- Stephen Kieran, James Timberlake. (2004). Refabricating architecture: how manufacturing methodologies are poised to transform building construction. McGraw-Hill Professional.

HISTORY OF BUILT ENVIRONMENT - I

IAE 115 **1-0-2-2**

Detailed study & analysis of architectural design fundamentals through significant examples in the light of the following for the periods mentioned in the modules -

Genesis of seed ideas & concepts; Timeline; Socio-political background, key people involved; Climatic & geographic influence; General settlement pattern; Cities & its civic places; Construction technology & material; Design principles; Typology; Evolution; Spatial organization; Form & Detailing.

The examples to represent the following historical styles are suggestive & students are encouraged to explore additional examples for a comprehensive understanding of the respective styles.

UNIT I - Mesopotamia: Sumer - City of Warka & Ur; Ziggurats - e.g. Ziggurat of Ur-Nammu, White Temple; City of Babylon - e.g. Ishtar Gate, Hanging Gardens; Assyria - City

of Khorsabad; Palace complexes - e.g. Palace of Sargon; Persia - City of Persepolis; Anatolia - Palace complexes.

UNIT II - Egypt: Typology - tomb complexes, temples, mortuary, cult temples & typical residences; Significance & evolution of Mastabas & Pyramids - e.g. Step pyramid at Sakkara, pyramid at Meydum, bent pyramid, pyramid complex at Giza; Corridor tombs; Temples - e.g. Temple of Khons, Karnak temple, temple at Abu-Simbel.

UNIT III - Other Civilizations: Overview; Indus Valley Civilization - e.g. Harappa & Mohenjo-Daro, Great Bath, The Granary; Oriental - China & Japan, Temples - e.g. temple of Heaven, temple complex of Horuji; Pagodas; Gateways; Tea houses; Pavilions; Gardens; Central & South America, Maya - e.g. City of Tikal, Inca - e.g. Machu Pichu, Aztec - City of Tenochtitlan.

UNIT IV - Greek Civilization: Aegean, Mycenaean - Types of masonry, Tholoso beehive tombs - e.g. Treasury of Atreus, Gate of Lions; Hellenic - Greek orders, Optical Illusions; City planning of Athens; The Acropolis; Greek temples - e.g. Parthenon, Erechtheion; Agora; Theatres - Theatre at Epidaurus.

UNIT V - Roman Civilization: The Roman orders; Temples - Pantheon; Public buildings & spaces; The Forums- e.g. Forum of Trajan; The Basilicas - The Basilica of Constantine; Thermae - e.g. Thermae of Caracalla; Theatres - e.g. Theatre of Marcellus; Amphitheatre - e.g. Colloseum; Circus - e.g. Circus Maximus; Aqueducts - e.g. Pont du Gard; Triumphal arches, victory pillars, town gateways, bridges, fountains.

TEXT/ REFERENCES:

- Copplestone, Trewin (ed), (1979). World Architecture. The Hamlyn Publishing Group Limited, Toronto.
- Fletcher, Sir Bannister. (1999). History of Architecture – 20th edition. Edited by Dan Cruickshank, CBS Publishers & Distributors, New Delhi.
- Gympel, Jan. (1996). The story of architecture. Könemann Verlagsgessellschaft mbH, Köln, Germany.
- Marian, Moffett et al. (2003). World history of architecture. Laurence King Publishing, London.
- Conway, Hazel and Roenisch, Rowan. (2005) Understanding architecture: an introduction to architecture and architectural history. Routledge.
- Marian Moffett, Lawrence Wodehouse and Michael Fazio. (2004). A World History of Architecture. McGraw-Hill Professional.
- Roth,Leland.(2006). Understanding Architecture: Its Elements, History, And Meaning. Westview Press.

PRINCIPLES OF ENVIRONMENTAL DESIGN

IAE 116 **2-0-0-2**

UNIT I - Introduction to Environment & Built Environment: Introduction to environment - types & basic components of environment; Ecosystem - structure, functions, classification of ecosystem; Biodiversity & its conservation, loss of biodiversity, hotspots; Ecological pyramids - ecological succession; Relation to built environment, considerations for ecology in historical built environment.

UNIT II - Built Environment: Urbanization - causes & impact of urbanization; Resources - types of resources, depletion of resources - causes & impacts on the environment; Climate change, global warming, greenhouse effect, depletion of ozone layer, Heat Island effect; urban sprawl, urban congestion; Pollutions; Carbon foot print - ecological foot print - carrying capacity; Basics of Sustainable Development - history & advancements till date; Overview of Burtland Commission's report.

UNIT III - Passive & Active Environmental Design: Introduction to Passive Environmental design - Heat flow in environment; Ventilation & Stack effect; Case studies in Indian context - spatial design, openings, courtyards, balconies, building materials & construction techniques; Introduction to Mud & Bamboo architecture, Organic architecture, Earth sheltered buildings. Introduction to Active Environmental Design - for water resources; solid waste management, energy efficiency; Managing construction waste.

UNIT IV - Disaster Management: Necessity; Types, characteristics, causes & impacts; Institutional & Legal arrangement; Disaster prevention & mitigation - risk assessment & vulnerability mapping; Preparedness - forecasting & early warning systems; Plans of action for probable disasters; Relief & Rehabilitation - temporary relief camps; Management of relief supplies; Relocation & reconstruction, repair & retrofitting of buildings & infrastructure; Role of Architect; Architectural Design considerations.

UNIT V - Case Studies for Eco-Friendly Design: Case studies of various contemporary designs done with principles of sustainability; Examples such as Solar Umbrella House, California/ Eastgate Centre, Harare, / California Academy of Life Sciences; Philosophies & works of eco-sensitive architects like - Nari Gandhi, Hassan Fathy, Geoffrey Bawa, Peter Busby, Norman Foster, Eric Corey Freed, R. Buckminster Fuller, Thom Mayne, William McDonough, Glenn Murcutt, Renzo Piano, Frank Lloyd Wright, Ken Yeang and others.

TEXT/ REFERENCES:

- P Venugopal Rao. (2008). Principles of Environmental Science and Engineering. Prentice Hall of India Private Limited, New Delhi
- Anil Kumar De and Arnab Kumar De. (2007). Environmental Studies. New Age International Publishers, New Delhi.
- Erach Bharucha. (2005). Text book of Environmental Studies for undergraduate courses. Universities Press, Hyderabad
- Benny Joseph. (2009). Environmental Studies, 2nd edition. Tata McGraw-Hill Publishing Company Ltd., New Delhi
- Goel SL and Kumar R. (2001). Disaster management. Deep and Deep publications.

II SEMESTER

ARCHITECTURAL DESIGN & DETAILING – STUDIO - II

IAE 121 **2-6-0-8**

UNIT I - Theme & Focus of Design: User-activity analysis; context; Functional & aesthetic requirements for development of design programme; Concept & detailed design with focus on load bearing structures using brick, stone; timber, etc.; Development of forms through sketches, models, case studies etc.

UNIT II - Basic Components: Behavioral Science; Functionality; Building Materials; Theory of Design; Form Development; Tectonic decisions - Structures, Building Materials, Services; Site Planning; Building Control Regulations; Inclusive Design; Design Communication.

UNIT III - Form Development: Exploring form in architecture; Importance; Principles of design; Evolution; Formulation & massing of multiple volumes in response to functional spaces; Interrelationship between multiple spaces & masses; Elements; Materials; Treatments; Stability. The Minor Exercise will be represented through conceptual development (sketches, physical & digital models).

UNIT IV - Design Analysis: Exploration & analysis of existing iconic Residential Architecture; Understanding design philosophy & process; Learning from design quality; Literature/book reviews; Architectural critiques.

UNIT V - Design Exercise: Single building for 4-6 users involving multiple activities & spaces; Residence for single family; Complexity of major design - Single building for 4-6 users involving multiple activities & spaces; Typology - Residence for single family; Site extent - Level site upto 500 m2.

TEXT/ REFERENCES:

- Ching Francis. (1979). Architecture Form, Space and Order. Van Nostrand Reinhold Company, New York.
- The National Building Code. (2000). IS Publications, India.
- IS Code Reference Manual for the Building Design for Physically Handicapped.
- Neufert Ernst. (1970). Architect’s Data. Crosby Lockwood and Sons, London.
- Chiara JD and Calender. (1983). Time Savers Standards for Building Types. McGraw Hill Book Company, New York
- Allen, Edward and Iano, Joseph. (2006). The Architect's Studio Companion: Rules of Thumb for Preliminary Design. Wiley; 4 edition.
- Frederick, Matthew. (2007). 101 Things I Learned in Architecture School. The MIT Press.
- Pearson, David. (2001). New organic architecture: the breaking wave. University of California Press.

STRUCTURAL & CONSTRUCTION SYSTEMS – STUDIO - II

IAE 122 2-2-2-5

UNIT I - Introduction: Structural behavior of beams, shear force, bending moment; Theory of simple bending, elementary stress analysis for bending, shear & deflections; Concept of flitch beam; Timber as construction material, properties.

UNIT II - Timber Roofs: Overview; Types & applications; Components, fixing, joinery details; Construction details; Earthquake resistance; Structural concepts; Details for lean-to roof, coupled roof, hipped roof & simple trusses; Application of timber roofs.

UNIT III - Stairs: Overview- Types, applications, various configurations; Timber stairs - components, fixing, joinery details; Structural concepts.

UNIT IV - Timber Floors: Overview - Types & applications; Timber floors - components, fixing, joinery details; Construction details; Earthquake resistance; Structural concepts.

UNIT V - Doors, Windows & Ventilators: Overview - Types & applications; Timber Doors & Windows - components, fixing, joinery details; Structural concepts.

TEXT/ REFERENCES:

- Bhavikatti, S.S. and Rajashekarappa, K.G. (2012), Engineering Mechanics; New Age International, New Delhi.
- Timoshenko, S and Young, D.H. (1951), Engineering Mechanics; Tata McGraw Hill Publishing company, New delhi.
- Kumar, K.L. (1986), Engineering Mechanics; Tata McGraw Hill Publishing company, New delhi.
- Singer, F.L. (1975), Engineering Mechanics; Harper and Row Publishers, NewYork.
- Ramamrutham, S. (1973), Strength of Materials; DhanpatRai Publications, NewDelhi.
- Timoshenko, S. (1983), Strength of Materials Part 1-2; Krieger Publishing Company, Florida.
- Stephens, R.C. (1970), Strength of Materials Theory and Examples; Edward Arnold Publishers Ltd., London.
- Punmia, B.C. and Goyal, S.C. (1965), Strength of Materials and Theory of Structures; Standard Publishing House, Delhi.
- Singh, G. (1964), Strength of Materials and Structures; Khanna Publishers, New Delhi.
- Punmia, B.C. and Ashok Kumar Jain (2014), Building Construction; Laxmi Publications Pvt. Ltd; New Delhi.
- Hood (1942), Steel and Timber Structures; Tata McGraw Hill Publishing Company, New Delhi.
- Sobon Jack and Schroeder Roger (1984), Timber Frame Construction All About Post and Beam Building; Storey Publishing LLC, North Adoms.
- Findley, W. P. K. (1975), Timber Properties and Uses; Crosslley, London.
- Scofield Fleming W.(1954), Modern Timber Engineering; Southern Pine Association, New Orleans.

- Chudley Roy and Roger Greeno (1990), Building Construction Handbook; Heinmann Press, Oxford.
- McKay, W.B.(2003), Building Construction; Orient Longman Publishers, Mumbai.
- Edward Allen and Joseph Iano (2009), Fundamentals of Building Construction: Materials and Methods; John Wiley & Sons Publishing Company, New Jersey.

ARCHITECTURAL REPRESENTATION – STUDIO - II

IAE 123 **1-1-3-3**

UNIT I - Development of Surfaces: Objective of developing surfaces from 3D; Understanding of Sections & development of surfaces including true shapes; Exercises - Isometric views / Free hand sketching of sectioned objects, furniture, etc.; Dot & line rendering.

UNIT II - Perspectives: Introduction to the Perspective Plane & theory of perspectives; Exercises in 1 Point & 2 Point perspectives with different eye levels & station points; Introduction to the theory of Sciography & application of the same in 2D & 3D drawings; Interpenetration of Solids - basic understanding; Sketching of shadows in complex volumes.

UNIT III - Color: Basics of Color Theory, Free hand rendering of Landscapes & builtscapes including human figures; Exercises; Application of Color in Architectural rendering; Monochromatic & Supplementary color schemes; Relation between color & texture.

UNIT IV - Massing of Volumes: Understanding the spaces & massing of built form; Understanding the positive & negative spaces; Sketching of buildings - understanding massing & forms; Facades - recess & relief models; 3D models for understanding volumes.

TEXT/ REFERENCES:

- Bhatt, N D. (2006). Engineering Drawing. Charotar Publishing House, Bangalore, India.
- Gopalakrishna, K R. (2007). Engineering Graphics. Subhas Publications, Bangalore, India.
- Mathur M L, Vaishwanar R S.(2009. Engineering Drawing and Graphics. Jain Brothers, New Delhi
- Venugopal, K. (2005). Engineering Drawing and graphics plus AutoCAD. New Age International , New Delhi
- Mathur M L , Vaishwanar R S. (2009). Engineering Drawing and Graphics. Jain Brothers, New Delhi
- Yee, Rendow. (2007). Architectural Drawing: A Visual Compendium of Types and Methods. Wiley; 3 edition.
- Ching, Frank (1996). Architectural Graphics, Van Nostrand Reinhold Publishing Company, New York.
- Ching Francis. (1979). Architecture Form, Space and Order. Van Nostrand Reinhold Company, New York.
- Garcia Joe (2002), Mastering the Water Colour Wash; North Light Books, Ohio.
- Agoston G. A.(1987), Color Theory and its Application in Art & Design; Newyork-Springer Verlag.

BUILDING SERVICES - I

IAE 124 **1-0-2-2**

UNIT I - Water Supply I: Sources of water; Collection & treatment of water from different sources; Drinking water standards; Estimation of water requirement - per capita demand, storage, distribution systems - layout & design considerations.

UNIT II - Water Supply II: Network for building; Components of water supply - selection & sizing; Pumps, pipes & pipe appurtenances; Suction tanks, Overhead tanks; Piping systems - in low, medium, high-rise buildings & residential layouts; Case studies & design problems; Hot water supply systems; Codes & standards; Symbols for representation.

UNIT III - Sanitation: Purpose & Principles; Systems of sanitation; House drainage (sewage, sullage) - collection & disposal fittings for low, medium & high rise Buildings; Community drainage - Self-cleansing velocity; Laying & testing of sewers; Sewers & sewer appurtenances; Pattern of sewage collection systems, Sewage treatment - Primary & secondary treatment; Septic tank, STP, oxidation pond, soil absorption system; Sewage effluent disposal; Rural sanitation; Codes & standards; Plumbing drawing.

UNIT IV - Drainage: Precipitation & run-off; Roof drainage; Site Drainage; Urban drainage; Sub soil drainage; Basement drainage; Storm water drainage system; Types & layout of drainage systems - Drains, materials, workmanship, clearing; Codes & standards; Rain Water Harvesting.

UNIT V - Solid Waste Management: Types of Refuse; Importance of SWM; Segregation, collection, treatment & disposal at different scales & typologies; Recycling; Best practices; Economic benefits.

TEXT/ REFERENCES:

- Birdie J.S. and Birdie G.S. (1998). Water Supply and Sanitary Engineering. Dhanpathray Publishing Company, New Delhi.
- Burke, Ken. (1982). Basic Plumbing Techniques. Ortho Books, Chevron Chemical Company, San Ramon, Canada.
- Hussain, S.K. (1982). Water Supply and Sanitary Engineering. Dhanpatray and Sons, New Delhi.
- Rangwala, S.C. (1969). Fundamentals of Water Supply and Sanitary Engineering. Charotar Publishing Company, Anand.
- Wise, Alan Frederick Edward & Swaffield, J.A. (2002). Water, Sanitary & waste Services for Building, 5th edn. Butterworth-Heinemann, Oxford.
- National Building Code of India.

HISTORY OF BUILT ENVIRONMENT – II

IAE 125 **1-0-2-2**

Detailed study & analysis of architectural design fundamentals through significant examples in the light of the following for the periods mentioned in the modules –

Genesis of seed ideas & concepts; Timeline; Socio-political background, key people involved; Climatic & geographic influence; General settlement pattern; Cities & its civic places; Construction technology & material; Design principles; Typology; Evolution; Spatial organization; Form & Detailing.

The examples to represent the following historical styles are suggestive & students are encouraged to explore additional examples for a comprehensive understanding of the respective styles.

UNIT I - Early Christian: Evolution of church- e.g. Church of Lateran & Old; St. Peters, Church of Holy Sepulcher; Byzantine - e.g. Hagia Sophia & St. Marks, Venice; Romanesque: e.g. Pisa Cathedral complex, Italy, Durham Cathedral, Britain.

UNIT II - Gothic: Early & late Gothic churches & regional variations - e.g. Notre Dame, France; Salisbury Cathedral, EngLand; Cologne Cathedral, Germany.

UNIT III - Renaissance: Ideologies & Works of famous architects & sculptors e.g. Brunelleschi, Alberti, Raphael, Michelangelo, Bernini & others; Cathedrals - e.g. St. Peters, Rome & St. Paul's, London.

UNIT IV - Baroque: Ideologies & Works of famous architects & sculptors like Bernini, Carlo Maderno & Borromini; Public spaces & plazas - e.g. St. Peters square, Rome; Fountains e.g. Fountain of four rivers & the Trevi; Rococo - Overview.

UNIT V - Overview of Miscellaneous Periods: Various styles, movements & schools of thoughts in Industrial, Modern & Postmodern era; Influences on the built environment - Neo classicism, Industrial Revolution, Arts & Crafts Movement, Art Nouveau, Art Deco, Expressionism, Modernism, Structuralism, Metabolism, Post Modernism, Minimalism, Hi-Tech, Novelty, New Expressionism, Critical Regionalism, De-constructivism, Blobitecture, Bionic, etc., through ideologies & landmark designs.

TEXT/ REFERENCES:

- Copplestone, Trewin (ed). (1979). World Architecture The Hamlyn Publishing Group Limited, Toronto.
- Fletcher, Sir Bannister. (1999). History of Architecture – 20th edition. edited by Dan Cruickshank, CBS Publishers & Distributors, New Delhi.
- Gympel, Jan. (1996). The story of architecture. Könemann Verlagsgessellschaft mbH, Köln, Germany.
- Marian, Moffett et al. (2003). World history of architecture. Laurence King Publishing, London.
- Conway, Hazel and Roenisch, Rowan. (2005). Understanding architecture: an introduction to architecture and architectural history. Routledge.
- Marian Moffett, Lawrence Wodehouse and Michael Fazio. (2004). A World History of Architecture. McGraw-Hill Professional.

PRINCIPLES OF LANDSCAPE DESIGN

IAE 126 **2-0-0-2**

UNIT I - Introduction to Landscape Architecture: Importance of nature for human beings; Need & scope of landscape architecture; Integration with architectural design & sustainable development; Role of a landscape architect; Landscape elements - land, vegetation, water, earth & climate; Natural & manmade elements; Principles of landscape design such as - unity, simplicity, variety, balance, proportion, sequence; Application in design

UNIT II - History of Landscape Architecture: Natural & cultural factors of the place; Development of landscape architecture through history in different parts of the world - China, Japan, Europe, Italy, France, England, Persia, Egypt, Greece, Rome; Medieval period in India - Mughal; Modern & Contemporary Landscape architecture.

UNIT III - Hardscape & Softscapes: Hardscapes - pergolas, garden furniture, fences, rocks, masonry, paving & surfacing, roads & parking lots, walks & plazas; Softscapes - Plantation, Turfing, Water features; Design criteria - visual, functional, micro-climatic, ecological, aesthetic; Symbolic aspects.

UNIT IV - Landscape Services & Sustainability: Introduction; Outdoors lighting, surface water drainage, irrigation, soil management techniques; Introduction to sustainable aspects in landscape architecture; Bio swales, xeriscaping, wet land, efficient irrigation by using grey water; Recycling of products.

UNIT V - Introduction to Site Planning: Aspects & representations; Site analysis - identification of elements on site & surroundings; Their impact on site; Site grading, survey maps, slope analysis, site sections, retaining walls, surfacing & paving, fencing & screening; Pedestrian & vehicular circulation; Site furniture; Landscape detailing - landscape constructional details of the following - paving, curbs, steps, roof garden, retaining walls; Landscape specification writing.

TEXT/ REFERENCES:

- Birlested, Jan. (1998). Relating Architecture to Landscape. E and F N Spon, London.
- Booth, Norman K. and Hiss, James E. (1991). Residential Landscape Architecture. Prentice Hall, New Jersey.
- Cerver, F A .(1997). International landscape architecture. F A Cerver, Spain.
- Laurie, M. (1986). Introduction to Landscape Architecture. Elsevier, New York.
- Lynch, Kevin and Hack, Gary. (1988). Site planning. MIT Press, Cambridge.
- Simonds, J. O. (1983). Landscape Architecture: A manual of site planning and design. McGraw Hill, New York.
- John Fleming, Hugh Honour. (2004).The Penguin Dictionary of Architecture and Landscape Architecture. Penguin; 5th Revised edition edition.
- Simonds, John.(1978). Earthscape a Manual of Environmental. McGraw-Hill Customer Service.

III SEMESTER

ARCHITECTURAL DESIGN & DETAILING – STUDIO - III

IAE 231 **2– 6– 0– 8**

UNIT I - Theme & Focus of Design: Study & analysis of various user types & their activities in public buildings; Development of design programme; Concept & detailed design with focus on RCC structures.

UNIT II - Basic Components: Behavioral Science; Functionality; Building Materials; Theory of Design; Form Development; Tectonic decisions: Structures, Building Materials, Services; Site Planning; Building Control Regulations; Inclusive Design; Design Communication.

UNIT III - Landscape Detail: Importance, exploring & understanding the essence; Detailing process; User analysis; Elements; Functionality & aesthetics; Materials. This Minor Exercise will be represented through conceptual development (sketches, physical & digital models).

UNIT IV - Exploration of Sloping Sites: Exploration & analysis of existing iconic designs on sloping sites; Understanding design philosophy & process; Learning from design quality; Literature/book reviews; Architectural critiques.

UNIT V - Design Exercise: Design of Multi- Functional Building/s for 30 to 40 users; Typology: Art Gallery, Library, Motel, Cultural Centre, Nursery, Kindergarten, Recreational Club, Guest House, etc.; Site extent - sloping site upto 8000 m2; Topography - average slope ranging from 1:5 to1:8.

TEXT / REFERENCES:

- Ching Francis. (1979). Architecture Form, Space and Order. Van Nostrand Reinhold Company, New York.
- Neufert Ernst. (1970). Architect's Data. Crosby Lockwood and Sons, London.
- Chiara JD and Calender. (1983). Time Savers Standards for Building Types. McGraw Hill Book Company, New York.
- Kolarevic, Branko. (2003., Architecture in the digital age: design and manufacturing. Taylor & Francis.
- Vesely, Dalibor. (2004). Architecture in the age of divided representation: the question of creativity in the shadow of production. MIT Press.
- BIS. (2005). The National Building Code of India, SP:7. Bureau of Indian Standards, New Delhi.
- BIS. (1987). Recommendations for Buildings and facilities for the Physically Handicapped. Bureau of Indian Standards.

STRUCTURAL & CONSTRUCTION SYSTEMS – STUDIO – III

IAE 232 **2– 2– 2– 5**

UNIT I - Fundamentals of Reinforced Cement Concrete: History & evolution; Building components; Grade of concrete & steel; Tests for concrete; Reinforcement in RCC structures; Aspects of fire & earthquake resistant RCC design; Working load, factored load; Working stress method & Limit state method; Overview of advancements in concrete technology.

UNIT II - Horizontal Support Systems: Types & concept; Analysis & design of singly reinforced, doubly reinforced sections; Reinforcement for ductile detailing in beams; BIS codes.

UNIT III - Slab & Roof Systems: Types of roof systems based on structural concepts; Analysis & design of one way & two way slabs; Reinforcement detailing; BIS codes.

UNIT IV - Vertical Support Systems: Types of columns & footings; Shear walls; Analysis & design of axially loaded short columns & isolated shallow footings; Reinforcement for ductile detailing; BIS codes; Overview of deep foundations.

UNIT V - Miscellaneous Structures: Types of staircases with design of typical staircase; Overview of water tanks, ramps, retaining structures, floating columns, machine foundations, heavy duty flooring etc.; Materials & methods for water-proofing & damp-proofing.

TEXT / REFERENCES:

- McKay, G.B. (1972). Building Construction (Metric). Longman, London.
- Chudley R. (1998). Construction technology. ELBS, England.
- Salvadori, Mario and Heller, Robert. (1963). Structure in Architecture — the building of buildings. Prentice-Hall, New Jersey.
- Dr.T.S.Balagopal Prabhu. (1987). Building Drawing and Detailing. Spades Publishers Pvt Ltd Calicut.
- Indian Standard Code: IS 456. (2000). Bureau of Indian Standards, New Delhi
- Other Relevant IS Codes.
- Raju N Krishna. (2003). Design of reinforced concrete structures. CBS Publishers, Delhi
- Gupta Ashok Kumar. (1999). Design of reinforced concrete structures. Galgotia, Delhi
- Subramanian, N (2013), Design of Reinforced concrete structures , Oxford University Press.

ARCHITECTURAL REPRESENTATION – STUDIO - III

IAE 233 **0– 2– 3– 3**

UNIT I - 2D Drafting: Introduction to CAD; Precision drawing & drawing aids, Draw commands for creating shapes; Edit/Modify commands; Annotating in AutoCAD with text & hatching; Layers, Dimensioning; Architectural views & drafting Views; Templates &

design center, Blocks, Drafting symbols, Attributes; Extracting data, Plotting (Layouts, Viewports); Office standards & preparation of presentation drawings.
UNIT II - 3D Modelling: Using 3D visualization software to study modeling such as surfaces & solids; Creating 3D compositions.

UNIT III - Rendering & Animation: Understanding rendering techniques using advanced software; Study of light, color, texture, animation, etc.

TEXT / REFERENCES:

CAD Manuals

BUILDING SERVICES - II

IAE 234 **1– 0– 2– 2**

UNIT I - Artificial Lighting: Fundamentals; Behavior of light; Quality, light quantity; Lamps & luminaires - characteristics, selection criteria, lumen method; Interior & exterior lighting; Preparation of lighting schemes; Best practices, codes; Case studies.

UNIT II - Building Electrification I: Power generation & transmission; Characteristics; Basics of electrical circuit - lighting & power circuit; Conductor, cables, controls & other components; Wiring methods; Accessories - switches, meters, fuses, circuit breakers, distribution boards.

UNIT III - Building Electrification II: Basic quantification; Electrical drawing, symbols; Power requirement of building - low, medium & high rise buildings; Load estimation; Building substation, transformer, HT, LT units - space requirements, safety measures; Earthing, lightning arrestors; Stand-by power, alternate power; Regulation as per - NBC & other IS codes.

UNIT IV - Mechanical Transport Systems: Elevators - passenger & service, parking; Escalators - basic components, working & operation, types; Travelators; Conveyer belts; Elevator planning fundamentals; Performance indicator, location & arrangement; Installation related civil works; NBC regulations; Current trends; Illustrations & drawings; Case studies.

UNIT V - Fire Fighting & Life Safety: Basic principles, elements & terminologies; Fire-fighting in different building typologies - prevention, evacuation strategies, suppression measures; Fire-fighting services & planning; NBC standards – Fire safety codes & regulation; Primary & secondary case studies.

TEXT / REFERENCES:

- Stein/Raynolds and Mc Guinnes. (1966). Mechanical and Electrical Equipment for Buildings, Vol.1. John Wiley and Sons, NY.
- Egan, David M. (1983). Concepts in Architectural Lighting. McGraw Hill Book Company.

- Dagostino, F. R. (1978). Mechanical and Electrical Systems in Construction in Architecture. Reston Publishing Company, Prentice Hill Co., Virginia.
- BIS (1989) National Building Code of India. (1983). Bureau of Indian Standards, New Delhi.

HISTORY OF BUILT ENVIRONMENT - III

IAE 235 **2– 0– 0– 2**

Detailed study & analysis of architectural design fundamentals through significant examples in the light of the following for the periods mentioned in the modules –

Genesis of seed ideas & concepts; Timeline; Socio-political background, key people involved; Climatic & geographic influence; General settlement pattern; Cities & its civic places; Construction technology & material; Design principles; Typology; Evolution; Spatial organization; Form & Detailing.

The examples to represent the following historical styles are suggestive & students are encouraged to explore additional examples for a comprehensive understanding of the respective styles.

UNIT I - Ancient India: Indus Valley Civilization - residences & various public buildings; Vedic villages - e.g. Kaushambi; Mauryan Period - e.g. Pataliputra; Establishment of Buddhist school, its significance & contribution; Ashokan Architecture & edicts; Beginning of cave architecture - e.g. Barabar hills

UNIT II - Buddhist Architecture & Rock Cut Architecture: Stupas - e.g. Sanchi & Amaravathi; Rock cut Temples; Chaityas & Viharas - e.g. Bhaja, Karle, Kanheri, Ajanta & Ellora.

UNIT III - Evolution of Temple Architecture: Early Gupta & Chalukyan temples - rock cut, shrines, defined temple form; Early Gupta - Udaygiri caves, early temples at Sanchi & Tigawa, temples at Deogarh & Bhittargaon; Early Chalukyan: Temple form at Aihole - e.g. Lad Khan & Durga temples; Elements of Indo Aryan (Nagara) temples; Basic elements of a Hindu temple & different temple styles such as Latina, Valabhi, Shekhari, Phamsana & Bhumija.

UNIT IV - Nagara Temples of Kalinga (Odisha) & Chandela (Madhya Pradesh) Dynasties: Kalinga - Types of Deulas - e.g. Mukteshwara, Lingraj, Jagannath & Sun temple at Konark; Chandela - Principles of shikhara & urushringa; Overview of Khajuraho group of temples; Kandariya Mahadev at Khajuraho.

UNIT V - Solanki & Jain Architecture: Solanki (Gujarat, Rajasthan & parts of Central India) - e.g. Saas Bahu temple at Gwalior & Sun Temple at Modhera; Jain Temples - e.g. temples at Ranakpur & Mt. Abu; Gujarat - Adalaj, Palitana, Somnathpur; Architecture of Rajasthan - Jaipur, Udaipur, Jodhpur, Jaisalmer, Bikaner; Forts, palaces, public buildings & town planning.

TEXT / REFERENCES:

- Brown, Percy. (1976). Indian Architecture (Buddhist and Hindu period). 7th reprint, Taraporevala Sons & Co. Pvt. Ltd. Mumbai.
- Fergusson, James. (1997). History of Indian and Eastern Architecture, revised and edited with additions, Indian architecture by James Burgess and Eastern architecture by R. Phene Spiers, reprint, vol. I and vol. II. Low Price Publications, Delhi.
- Fisher, Robert E. (1993). Buddhist Art and Architecture. Thames and Hudson Ltd, London.
- Grover, Satish. (2003). Buddhist and Hindu Architecture in India, 2nd edition. CBS publishers and distributors, New Delhi.
- Deva, Krishna. (1995). Temples of India, vol. I and II. Aryan books international, Delhi.
- Marian Moffett, Lawrence Wodehouse and Michael Fazio. (2004). A World History of Architecture. McGraw-Hill Professional, ISBN-10: 0071417516
- Roth,Leland. (2006). Understanding Architecture: Its Elements, History, And Meaning. Westview Press, ISBN-10: 0813390451

PRINCIPLES OF CLIMATIC DESIGN

IAE 236 **2– 0– 0– 2**

UNIT I- Introduction to climatic design: Energy use & its implications. Introduction to various elements of climate & their impact on global, local, site & building context. Introduction to Micro (site) climate – effects of local factors, Landscape elements & any other elements in site. Introduction to urban heat isLand effect.

UNIT II- Impact of climate on design: Climate classifications in India. Study of climate conditions on a macro & micro level. Understanding climate zones & their influence over design guidelines for Warm & humid climate, Hot & dry climate, Composite climate & Cold climate.

UNIT III- Bioclimatic & low-energy design: Understanding the sun path & shading devices, orientation of building, openings- sizes, position. Study of Bioclimatic design & Low-energy design. Examples of Low-energy projects & discussion on solar architecture.

UNIT IV- Integrated passive design: Cooling & Heating: Understanding the psychometric chart. Daylighting & envelope design; Study of different passive cooling & heating strategies in buildings; Ventilation, courtyards, wind towers, stack effect & chimney.

UNIT V- Introduction to simulation software: Introduction to computer simulation for climatic design, software like Climate Consultant, HEED, Ecotect or related advanced software. Design of a space using simulation software with the application of principles of climatic design.

TEXT / REFERENCES:

- Brown, G. Z. (1985). Sun, Wind and Light: Architectural Design Strategies. John Wiley & Sons, New York.
- Evans, Martin. (1980). Housing, climate and comfort. Architectural Press, London.

- Koeningsberger, et. al. (1975). Manual of Tropical Housing and Building (Part-II). Climate Design, Orient Longman Ltd, Hyderabad.
- Mani, A. (1980). Handbook of Solar Radiation Data for India. Allied Publishers, New Delhi.
- Olgyay, A. and Olgyay, V. (1957). Solar Control and Shading Devices. Princeton University Press, New Jersey.
- Robbins, C. L. (1986). Daylighting: Design and Analysis. Van Nostrand Reinhold Co.

ELECTIVE - I

IAE 237 **0– 0– 2– 1**

The creative electives provide an opportunity to express talents which are different from architecture but related to imagination, visualization & creation. They offer hands-on experience of unique ingenuity & workmanship. The essence of creative domain can be achieved by exploring different materials, techniques, processes; developing creative products; finishing & presenting the product for the concepts evolved. Outcome will be through portfolio & presentations.

METAL ART

Overview- significance, scope & purpose; material types, source, composition, properties, tools & equipment, techniques, processes, finishing; applications – sculpture, wall art, garden art, sign art, accessories etc.

GLASS ART

Overview- significance, scope & purpose; material types, source, composition, properties, tools & equipment, techniques, processes, finishing; applications – Etching, Stained glass etc.

CLAY ART

Overview- significance, scope & purpose; material types, source, composition, properties, tools & equipment, techniques, processes, finishing; applications. Utilitarian/ Non-utilitarian products, pottery, sculpture, wall art, garden art, sign art, accessories etc.

WOOD ART

Overview- significance, scope & purpose; classification , selection , types, source, composition, properties, tools & equipment, techniques, processes, finishing; applications – Utilitarian / Non-utilitarian products, sculpture, wall art, sign art, engraving, fixtures, accessories etc.

IV SEMESTER

ARCHITECTURAL DESIGN & DETAILING – STUDIO - IV

IAE 241 **2- 6 -0 –8**

UNIT I- Theme & focus of design: Study, analysis & utilization of Non-Conventional Systems (alternative building technologies). Understanding, exploration & development of design programme, concepts & detailed design with focus on Stabilized Mud Blocks, Bamboo, Ferro-cement, etc. in urban &/or rural context.

UNIT II- Basic Components: Behavioral Science; Functionality; Building Materials; Theory of Design; Form Development; Tectonic decisions: Structures, Building Materials, Services; Site Planning; Building Control Regulations; Inclusive Design; Design Communication.

UNIT III- Gateways & Thresholds: Importance, Exploring & Understanding the essence; detailing process; User analysis; Elements; functionality, aesthetics; Materials. This Minor Exercise will be represented through conceptual development (sketches, physical & digital models).

UNIT IV- Design Analysis: Exploration & analysis of iconic Eco-sensitive Architecture; Understanding design philosophy & process; Learning from design quality, Literature/book reviews; Architectural critiques.

UNIT V- Design Exercise: Building Design. Complexity of design: Site planning involving multiple buildings; Detailing of any one building with alternative technology. Typology: Co-operative Societies, Vocational Training Centers, Rural Residential Schools, Bus Stations, Veterinary Centers, Temporary Shelters, Labour Camps, Ayurveda Centers, Naturopathy Centers, SOS Villages, Horticultural Centers, Ashram etc. Site extent: Flat site upto 8000 m2.

TEXT / REFERENCES:

- Ching Francis. (1979). Architecture Form, Space and Order. Van Nostrand Reinhold Company, New York.
- Neufert Ernst. (1970). Architect's Data. Crosby Lockwood and Sons, London.
- Chiara JD and Calender. (1983). Time Savers Standards for Building Types. McGraw Hill Book Company, New York.
- Kolarevic, Branko. (2003. Architecture in the digital age: design and manufacturing. Taylor & Francis.
- Vesely, Dalibor. (2004). Architecture in the age of divided representation: the question of creativity in the shadow of production. MIT Press.
- BIS. (2005). The National Building Code of India, SP:7. Bureau of Indian Standards, New Delhi.
- BIS. (1987). Recommendations for Buildings and facilities for the Physically Handicapped. Bureau of Indian Standards.
- Live Better with Mud and Thatch, Central Building Research Institute, Roorkee (1985)
- Berge Bjorn (2009), Ecology of Building Materials; Routledge, Newyork.

STRUCTURAL & CONSTRUCTION SYSTEMS –STUDIO - IV

IAE 242 2- 2 -2–5

UNIT I- Introduction: Need for alternative building materials & technology: Mud construction, bamboo technology, Ferro cement etc. Comparative studies with conventional Building Materials. Environmental benefits, energy aspects & cost effectiveness.

UNIT II- Ferro Crete, Fiber reinforced concrete, Filler slabs: properties, applications & construction techniques. Structural concepts with practical exposure.

UNIT III- Mud Architecture: Mud as a construction material. Various construction methods - COB, Rammed earth, Adobe, Daub, Stabilized mud blocks (SMB), compressed stabilized mud blocks (CSMB): Application, Construction techniques. Structural concepts with practical exposure.

UNIT IV- Finishes: Wall finishes, floor finishes, roof finishes, water proofing, insulations – thermal & acoustical. False ceilings. Paneling.

UNIT V- Miscellaneous materials & techniques: Shoring, underpinning, scaffolding, formwork, recycled materials, sustainable techniques, eco-friendly materials.

TEXT / REFERENCES:

- Live Better with Mud and Thatch, Central Building Research Institute, Roorkee (1985)
- Berge Bjorn (2009), Ecology of Building Materials; Routledge, Newyork.
- Lectures on Construction Practices followed at Auroville Research centre, Nirmithi Kendra etc.
- Janssen Jules, J.A., (1995), Building with Bamboo, Intermediate Technology Publications, UK.
- Hall Nicolas (1991), Thatching Handbook, Intermediate Technology Publications, UK.
- Punmia, B.C. and Ashok Kumar Jain (2014), Building Construction; Laxmi Publications Pvt. Ltd; New Delhi.
- Edward Allen and Joseph Iano (2009), Fundamentals of Building Construction: Materials and Methods; John Wiley & Sons Publishing Company, New Jersey.

ARCHITECTURAL REPRESENTATION – STUDIO - IV

IAE 243 0- 2 -3–3

UNIT I- Site Modelling: Introduction to BIM modeling, advantages; Creation of Terrains, Landscape elements.

UNIT II- Building Modelling : Building elements like walls, floors, roofs, doors, windows, openings, stairs, ramps, railings, curtain walls, structural elements such as columns, beams, slabs, foundations, etc.; Creating elevations, sections, 3d view; Working with grids for framed structures; Massing, creating masses & modification.

UNIT III- Customization: Creating families: Using components, creating new types & new families.
UNIT IV- Documentation: Creating schedules, materials takeoff.
UNIT V- Presentation: Rendering views, Creating walk- through, Print layouts.

TEXT / REFERENCES:

Online links for Autodesk Revit.

BUILDING SERVICES - III

IAE 244 **1- 0-2–2**

UNIT I- Fundamentals of Ventilation & Air Conditioning: Ventilation: Objectives, methods, air changes, comfort ventilation, standards; Mechanical Ventilation. Air Conditioning: Body comfort-psychometrics; Refrigeration Cycle – Compression & Absorption Cycle, Components of air conditioning, Parameters considered for air conditioning, concept for air based & water based cooling systems.

UNIT II- Air Conditioning Systems: Types; Air conditioning equipment – residential small units- water cooled & self-contained- air-cooled- cooling tower. Principles of load estimation- sources of heat- cooling & heating loads- estimation of load; Thermal insulation; Air distribution- ducts- outlets- duct sizing; Equipment selection – Zoning. Energy conservation techniques.

UNIT III- Acoustics I: Physics of sound - Sound propagation; Sound Measurement; Sound in enclosed space – Properties & behavior; Acoustical Defects; Constructional measures; various sound absorbing material & its applications. Acoustical properties of building materials, Sound insulation; Room acoustics: Reverberation time - control; design for listening room; acoustical requirements; Effects of noise - Environmental noise, Impact noise, Sound Transmission – airborne & structure borne noise, STC , Noise control techniques in different building types.

UNIT IV- Acoustics II: Acoustical design for performance spaces- drama hall, music, speech, cinemas, open air theatre, workplaces, education spaces, & other acoustically sensitive environments; Design of Theaters & Concert Halls, recording rooms- open air theatres; Designing of stage, seating & false ceiling design, Sound amplification systems; Acoustical treatment materials, Case studies; Calculations & designing of acoustical treatment of various spaces.

UNIT V- Contemporary Building Services: Intelligent Buildings: Concept & use; Sensors – working & application in – HVAC, Fire protection systems, security & safety systems & general energy efficiency. Building management / automation systems: principles, working & integration in building design, IBMS; Reticulated Gas Systems. IT Services: Communication systems, CCTV, Wireless systems; digital systems.

TEXT / REFERENCES:

- Egan, David. (1988). Architectural Acoustics. McGraw Hill Book Co., NY.
- Kinsleter, Lawrence E. and Frey Austin R. (1989). Fundamentals of Acoustics (ed.2). Wiley Eastern Ltd., New Delhi.
- Templeton and Saunders. (1987). Acoustic Design. Architectural Press, London.
- Blue Star. (1996). The Blue Star Guide to Comfort Air Conditioning, Blue Star Packaged Air Conditioner Devision.
- Flynn, J.E. et. Al.(1992). Architectural Interior Systems: Lighting, Acoustics and Air conditioning. Van Nostrand Reinhold Co.
- Jones, W.P. (1985). Air Conditioning Engineering. ELBS (Edward Arnold).
- Clements- Croome Derek (2014), Intelligent Buildings: An Introduction; Routledge, New York.

HISTORY OF BUILT ENVIRONMENT - IV

IAE 245 **2- 0-0–2**

Detailed study & analysis of architectural design fundamentals through significant examples in the light of the following for the periods mentioned in the modules –

Genesis of seed ideas & concepts; Timeline; Socio-political background, key people involved; Climatic & geographic influence; General settlement pattern; Cities & its civic places; Construction technology & material; Design principles; Typology; Evolution; Spatial organization; Form & Detailing.

The examples to represent the following historical styles are suggestive & students are encouraged to explore additional examples for a comprehensive understanding of the respective styles.

UNIT I- Evolution of South Indian Temples: Different Dynasties of early medieval South India; Vesara & Dravida Styles; Durga Temple, Lad Khan Temple at Aihole, Cave temples at Badami, Chalukyan Architecture at Pattadakal- Virupaksha Temple, Haveri, Hanagal, Banvasi.

UNIT II- Pallava & Pandya Dynasty: Rock cut Architecture- mandapas, monolithic temples (Rathas); Pancharathas & Shore temple at Mamallapuram; Kailasanatha temple & Vaikuntha Perumal Temple at Kanchipuram. Development under Pandya Dynasty- Development of Temple Citadel & Gopuram; e.g at Tiruvannamalai & Chidambaram.

UNIT III- Chola Dynasty & Madurai Dynasty: Development of Chola style & capital, Influence from Chalukyan style; Brihadeshwara Temple at Tanjore & Gangai Konda Cholapuram, Temples at Kumbakonam; Temple Architecture under Madurai Dynasty: development of Prakaarams & spaces in Temple, example of Madurai Meenakshi Temple.

UNIT IV- Hoysala, Vijayanagara & Nayaks: Vesara style; Chennakeshwara Temple at Belur, Hoysaleshwara Temple at Halebeedu, Keshava temple at Somnathapur; Vittala

Temple & Virupaksha temple at Hampi, Settlement pattern of Hampi; Temple towns of Kumbakonam, Kanchipuram, Srirangam, Madurai & Rameshwaram.

UNIT V- Kerala & South Canara: Temple complexes, temple towns, Basadis & palaces at various historical settlements such as- Udupi, Karkala, Moodabidri, Sringeri, Barkur, Kollur, Suchindram, Padmanabhapuram, Thiruvananthapuram, Kanyakumari, Thrissur, Palakkad, Calicut, Wayanad, Ernakulam, Alleppey.

TEXT / REFERENCES:

- Brown, Percy. (1976). Indian Architecture (Buddhist and Hindu period), 7th reprint. Taraporevala Sons & Co. Pvt. Ltd. Mumbai.
- Fergusson, James. (1997). History of Indian and Eastern Architecture, revised and edited with additions, Indian architecture by James Burgess and Eastern architecture by R. Phene Spiers, reprint, vol. I and vol. II. Low Price Publications, Delhi.
- Fisher, Robert E. (1993). Buddhist Art and Architecture. Thames and Hudson Ltd, London.
- Grover, Satish. (2003). Buddhist and Hindu Architecture in India, 2nd edition. CBS publishers and distributors, New Delhi.
- Deva, Krishna. (1995). Temples of India, vol. I and II. Aryan books international, Delhi.
- Marian Moffett, Lawrence Wodehouse and Michael Fazio. (2004). A World History of Architecture. McGraw-Hill Professional.
- Roth,Leland. (2006). Understanding Architecture: Its Elements, History, and Meaning. Westview Press.
- Mathpal Yashodhar (1996), Rock Art in Kerala; Indira Gandhi National Centre for Arts, New Delhi.
- Sarkar H. (1992), Monuments of Kerala; Archeological Survey of India, New Delhi.
- 10.Ramu Katakam (2006), Glimpses of Architecture in Kerala: Temples and Palaces, Rupa Publications, New Delhi.

PRINCIPLES OF SUSTAINABLE DESIGN

IAE 246 **2- 0-0–2**

UNIT I- Introduction: Concepts of Reduce, Reuse & Recycle; Environmental Legislations ; Climate change Protocols & Conventions ; MoEF Guidelines & Notifications; Overview of policies & development regulations governing sustainability issues; Economic approaches of measuring sustainable development; Project Life Cycle; Economic & environmental costs of green buildings.

UNIT II- Passive Systems: Resource optimization, Design methodologies- site & building level, Multiuser, Multi-functionality, Adaptability, & flexibility; Building technologies, materials & detailing; Spatial considerations; Components; Interior optimization; Site & building maintenance.

UNIT III- Energy Systems: Energy, Thermodynamics & Building Physics; Heat transfer, ventilation & insulation of buildings; Design strategies; Active Energy Systems in Buildings: HVAC, Electrical, Mechanical Building Systems, ECBC, BEE, LEED &

GRIHA; Solar Passive Energy Design systems; Measuring energy efficiency; Simulation through the use of computer based applications.

UNIT IV- Water Management: Management of natural water sources; Designing for water conservation – traditional & modern; Techniques of water management- natural & manmade; Reduction of water consumption, Reuse of resources & recycling of waste water; Rain water harvesting; Considerations at site, Landscape & building level.

UNIT V- Waste Management: Types; Waste minimization; Segregation; Recycling waste as alternative material for buildings, Landscape & other products; Processing; Study of innovative practices; Specifications & construction methods for using recycled waste- agricultural, industrial, municipal, domestic; Demonstrative architecture & Landscape using waste.

TEXT / REFERENCES:

- Hal R. Varian (2010), Intermediate Microeconomics, A Modern Approach, Eighth Edition; W.W. Nortan and Company, London.
- Energy Conservation Building Code- User Guide (2009); Bureau of Energy Efficiency, New Delhi.
- Climate change, Synthesis Report; Intergovernmental Panel on Climate Change.
- Koeningsberger, et. al. (1975). Manual of Tropical Housing and Building (Part-II). Climate Design, Orient Longman Ltd, Hyderabad.
- Online portal of Ministry of Environment, Forests and Climate Change.
- Rao M. N. and Dutta A.K. (1979), Waste Water Treatment; Oxford and IBH, Delhi.
- Hammer Mark J. (2000) Water and Waste Water Technology, Prentice Hall of India, Delhi
- Kumar Rakesh and Singh R.N. (2006), Municipal Water and Waste Water Treatment; Capital Publishing Company, New Delhi.
- Hammer Mark and others (2005), Water and Waste Water Technology; PHI, New Delhi.
- Glen B. Philip, Green Building Principles and LEED, Greence Inc.
- Rating Systems on Green Buildings such as GRIHA, LEED etc.
- Green Building online Inc. (2013-2018), LEED Green Associate (LEED v4), Poplar Education.

ELECTIVE - II

IAE 247 **0- 0-2–1**

The creative electives provide an opportunity to express talents which are different from architecture but related to imagination, visualization & creation. They offer unique experience of ingenuity & creativity. The essence of creative domain can be achieved by exploring different technology, techniques, processes, concepts, compositions. Outcome will be through portfolio & presentations.

CREATIVE PHOTOGRAPHY

Overview- principles, recent advancements; significance, scope & purpose; types, composition, tools & equipment, technology, techniques, processes, presentation; categories-themes, location, objects, patterns, light & shade, nature, still photography, actions & expressions, details, culture, panorama, frames, metaphor etc..

CREATIVE WRITING

Overview- Definition, Description, significance, scope & purpose; techniques. Types – prose, poetry, plays, lyrics, speeches, etc.; Factors of study: plot & situation, themes, dialogue, structure, character, voice, description, expression, interpretations, metaphor, point of view etc.

CREATIVE FASHION

Overview- Definition, Description, significance, scope, purpose, tools & techniques, materials; types; Basics of human anatomy. Pattern making – methods, tools. Taking measurements, preparing patterns - Drawing fashion figures, Fashion poses, rendering details. Garment construction: Stitching the garment for the patterns made.

CREATIVE GARDENING

Overview- Definition, Description, significance, impact, scope & purpose; tools & techniques, materials; types; Basics of plants & horticulture; site situation & appropriate themes, elements of gardening, execution & detailing, maintenance.

V SEMESTER

ARCHITECTURAL DESIGN & DETAILING – STUDIO - V

IAE 351 **2-6-0-8**

UNIT I- Theme & focus of design: Study, analysis & utilization of Contemporary Structural Systems in Hi-tech Architecture; Understanding, exploration & development of design programme, concepts & detailed design with focus on Steel.

UNIT II- Basic Components: Behavioral Science; Functionality; Building Materials; Theory of Design; Form Development; Tectonic decisions: Structures, Building Materials, Services; Site Planning; Building Control Regulations; Inclusive Design; Design Communication.

UNIT III- Temporal Architecture: Importance, Exploring & Understanding the essence; detailing process; User analysis; Elements; functionality, aesthetics; Materials. This Minor Exercise will be represented through conceptual development (sketches, physical & digital models).

UNIT IV- Design Analysis: Exploration & analysis of works of iconic Hi-tech Architecture; Understanding design philosophy & process; Learning from design quality, Literature/book reviews; Architectural critiques.

UNIT V- Design Exercise: Building Design. Complexity of design: Multi-storied building/s or large span structures. Focus on building services as an integral part of the design & construction process. Typology: Transport Hubs, Shopping Malls, Hotels, Hospitals, Media Houses, Broadcasting Stations, Sports Facilities, Apartments, etc. Site extent: Up to 8000 m^2.

TEXT / REFERENCES:

- Ching Francis. (1979). Architecture Form, Space and Order. Van Nostrand Reinhold Company, New York.
- Neufert Ernst. (1970). Architect's Data. Crosby Lockwood and Sons, London.
- Chiara JD and Calender. (1983). Time Savers Standards for Building Types. McGraw Hill Book Company, New York.
- Kolarevic, Branko. (2003., Architecture in the digital age: design and manufacturing. Taylor & Francis.
- Vesely, Dalibor. (2004). Architecture in the age of divided representation: the question of creativity in the shadow of production. MIT Press.
- BIS. (2005). The National Building Code of India, SP:7. Bureau of Indian Standards, New Delhi.
- BIS. (1987). Recommendations for Buildings and facilities for the Physically Handicapped. Bureau of Indian Standards.
- Broto Carles (2005), Iconic Design Hotels; Arian Mostaedi, Spain.

STRUCTURAL & CONSTRUCTION SYSTEMS – STUDIO - V

IAE 352 2-2-2-5

UNIT I- Introduction: Steel as a construction & structural material, steel sections, load cases & combinations. Limit State Method (LSM) of design, design criteria, applications.

UNIT II- Metal Building components: windows, doors, stairs, collapsible gates, rolling shutters, railings, BIS Codes.

UNIT III- Frame & Roof systems: Steel stanchions, girders, trusses: Characteristics, types, components, selection, applications, structural sizing, fabrication & erection. Castellated beam, Portal frames, Steel connections. Analysis & Design of simple trusses.

UNIT IV- Curtain wall: Characteristics, types, components, selection, applications, structural sizing, connections.

UNIT V- Advanced Systems: Space frames; Pre-engineered buildings, fire protection. Overview: tall structures, large span structures.

TEXT / REFERENCES:

- R. Chudley. Construction Technology, Vol.3, 4, 5. ELBS, Longman group.
- McKay, W.B. (1972). Building Construction (Metric). Longman, London.
- Foster, Stroud. (1963). Mitchell's Advanced Building Construction. Allied Publishers Pvt.Ltd., Bombay.
- Gyala, Sabestyen. (1977). Light Weight Building Construction. George Godwin Limited, London
- Ramamrutham S, Narayan R. (2008). Theory of Structures. Dhanpat Rai Publishing Company Pvt.Ltd., New Delhi.
- Balagopal T.S.Prabhu. Building Design and Civil Engineering Drawing. Spades Publishers, Calicut.
- Barry, R. (1999). Construction of Buildings.
- Chandra Ram.(2003). Design of Steel Structures. Standard Book House, Delhi.

- IS 800 : 2007. General Construction in Steel – Code of Practice. Bureau of Indian Standards, New Delhi
- SP:6(1)-1964:Hand Book for Structural Engineers - Structural Steel Sections.
- Vazirani V N, Ratwani M M. (2003). Design and Analysis of Steel Structures and Timber Structures. Khanna Publishers, Delhi
- Duggal S K. (2005). Design of Steel Structure. TMH, New Delhi
- Negi L S. (2003). Design of Steel Structure. TMH, New Delhi
- Arya A S, & Ajimani J L. (1996). Design of Steel Structure, Nem chand, Roorkee.

WORKING DRAWING & DETAILING – STUDIO – I

IAE 353 **1-1-3-3**

UNIT I- Overview: Working Drawing, Estimation & Specifications; Liaison drawings; Standards, guidelines for execution of works, Units of measurements; Writing specifications; Methods of estimation; Rate analysis of relevant items.

UNIT II- Centre line drawing, Excavation drawing, Foundation details & Floor Plans
UNIT III- Roof Plan including roof drainage, Stair room plan.

UNIT IV- Sections, Elevations; Wall sections; Section through stairs & toilet is mandatory.

Note: All Modules to include drawings & details; estimation & specifications.

TEXT / REFERENCES:

- CPWD (1987) Schedule of Rates. Government of India Publications, New Delhi.
- Dutta, S. (1989). Estimating and Costing (ed.20). S.Dutta and Co., Lucknow.
- Rangawala, S.C. (1984). Estimating and Costing. Charotar Publishing Co.
- Relevant BIS Codes for Material Specifications.
- Waktia, Osamu and Linde, Richard. (1977). The Professional Practice of Architectural Detailing. John Wiley and Sons, N.Y.
- Thomas, Marvin. (1978). Architectural Working Drawings: A Professional Technique. McGraw Hill Book Co., N.Y.
- Watila, A & Richard M.Linde. The Professional Practice of Architectural Working Drawings by Osamu. ISBN-10:0471395404, ISBN-13:978-0471395409.

PROJECT MANAGEMENT

IAE 354 **1-0-2-2**

UNIT I- Introduction : History; Stages involved; Project life cycle analysis; Role & responsibilities of project manager; Areas of project management; Co-ordination of various teams involved in the project; Scheduling; Classification; Methods; Controlling & Life cycle curves; Work breakdown structure.

UNIT II- Project Management through Networks: Network techniques; Interrelationship of events & activities; Dummy activities; Types of networks; Rules of drawing a network; Fulkerson's rule.

UNIT III- Project management techniques: Program Evaluation & Review Technique; & Critical Path Method; Time Estimates; Networking with PERT models; Probability analysis.

UNIT IV- Precedence Networks for Construction Projects: Representation of Nodes; Logic of Precedence diagram; Rules for drawing; Forward pass & backward pass calculations.

UNIT V- Time-Cost Relationship: Total Project Costs; Cost curve; Optimization of Cost through Network Contraction & steps involved; Cost control & cash flow; Case studies- Application of knowledge & Understanding of project management tools.

TEXT / REFERENCES:

- Chitkara, K. K. (1999). Construction Project Management: Planning, Scheduling and Controlling. Tata McGraw-Hill Pub., New Delhi.
- Gould, E., Frederick and Joyce, E. Nancy. (2000). Construction Project Management. Prentice Hall, New Jersey.
- Gupta, B.L. and Gupta, Amit. (2005). Construction Management, Machinery and Accounts, 3rd ed. Standard Pub.
- Loraine, R.K. (1993). Construction Management in Developing countries. Thomas Telford, London.
- NICMAR (1990). Construction Machines & Equipment. National Institute of Construction Management and Research.
- Peurifoy, R. I. (2007). Construction Planning Equipment and Methods, McGraw Hill.
- Sharma, S.C. (2004). Construction Equipment and its Management, 4th edn. Khanna Pub., New Delhi.
- Namavathi Roshan. (1993). Professional Practice. Lakshmi Book Depot
- Ashwath Damodaran. (2002). Investment Valuation: Tools & Techniques for determining the value of any asset

HISTORY OF BUILT ENVIRONMENT - V

IAE 355 **1-0-2-2**

Detailed study & analysis of architectural design fundamentals through significant examples in the light of the following for the periods mentioned in the modules –

Genesis of seed ideas & concepts; Timeline; Socio-political background, key people involved; Climatic & geographic influence; General settlement pattern; Cities & its civic places; Construction technology & material; Design principles; Typology; Evolution; Spatial organization; Form & Detailing.

The examples to represent the following historical styles are suggestive & students are encouraged to explore additional examples for a comprehensive understanding of the respective styles.

UNIT I- Islamic Architecture in India: Overview; Development of various building typologies & incorporation of indigenous elements, development of construction systems & elements; Integration of Islamic planning principles into urban settings; Various dynasties & their influence: Slave, Khilji, Tughlaq, Sayyid & Lodi; Significant examples for each dynasty.

UNIT II- Provincial Islamic Style: Development of provinces & evolution of regional architecture; Geographic, social, cultural, political influences; M&u, Bengal, Gujarat, Avadh, Bihar, Bhopal, Jaunpur, Deccan (Gulbarga, Bidar, Golconda, Bijapur), Tipu's dynasty; Significant examples for each province.

UNIT III- Mughal Architecture: Development of Mughal Architecture by various rulers- Babur, Humayun, Akbar, Jahangir, Shahjahan & Aurangazeb; Geographic, social, cultural, political influences; Incorporation of local styles, skills, materials & elements; Development of Settlements, Building typologies & Gardens; Study of significant examples at Delhi, Agra, Sikri, Kashmir.

UNIT IV- Colonial Architecture- British: Overview, Evolution of Indo-Saracenic style of Architecture, fusion of Indian regional architecture with European styles; Development of various typologies like Forts, Bungalows, Cantonments, Public buildings, Transportation nodes, Institution, Industries & Commercial buildings; Architectural examples from prime British settlements of Calcutta, Madras, Bombay & New Delhi.

UNIT V- Colonial Architecture- Others: Imperial power in various places of India; French- Pondicherry; Dutch- Coromandel & Malabar; Portuguese-Goa. Influence on Local architecture & settlements; Development of various typologies like Forts, Ports, Bungalows, Public buildings, Religious buildings, Commercial buildings & Markets.

TEXT / REFERENCES:

- Asher, Catherine B. (1992). The New Cambridge History Of India, I: 4, Architecture of Mughal India. Cambridge University Press.
- Brown, Percy. (1976). Indian Architecture (Islamic period), 7th reprint. Taraporevala Sons & Co. Pvt. Ltd. Mumbai.
- Fergusson, James. (1997). History of Indian and Eastern Architecture, revised and edited with additions, Indian architecture by James Burgess and Eastern architecture by R. Phene Spiers, reprint, vol. I and vol. II. Low Price Publications, Delhi.
- Fletcher, Sir Banister. (1996). A History of Architecture, Dan Cruickshank (ed.) 20th edition. CBS Publishers & Distributors, New Delhi.
- Goodwin, Godfrey. (1971). A history of Ottoman architecture. London, Thames and Hudson.
- Grover, Satish. (2003). Islamic Architecture in India, 2nd edition. CBS publishers and distributors, New Delhi.
- Nunes Judilia (1979), Monuments in Old Goa; Agamkala Prakashan, Delhi.
- Cunha GerardDa (1999), Houses of Goa; Archiworld Co-Ltd.

PRINCIPLES OF URBAN DESIGN

IAE 356 **2-0-0-2**

UNIT I- Introduction: Introduction to Urban Design; Terminologies; Stake holders & their role in the process of Urban Design; Urban Design as Multidisciplinary field; Necessity & benefits of quality urban design; Scope, strategies, levels, legislation & scale of Urban Design.

UNIT II- People's Perception: Users and activities in a city and their analysis. Behavioral studies and user needs. Socio-cultural and socio economic aspects. Different zones and activities in an urban area. Memory and mental mapping, the Five Elements in a city. People-centric design and public participation.

UNIT III- Anatomy of an Urban Area: Urban morphology & urban character; Elements & aspects of Urban Design; Built & Unbuilt spaces; Buildings, public spaces, streets & transport; pedestrianisation & street scape; movement pattern; services; safety & sensitive urban development – defensible spaces. Nature and urban design - open spaces; Environment & urban design.

UNIT IV- Urban Design Process: Survey techniques; Evolution analysis; Townscape analysis; Perceptual structure; Permeability study (privacy & accessibility) & visual analysis. Constraints & possibilities; Designing in a context and site planning; Articulation of spaces; Multi-functionality, flexibility, adaptability; Generating alternatives; Formulation of issues for intervention.

UNIT V- Application of Urban Design: Examples of good urban design; Urban design in history, aspects of heritage and historical continuity; Applications of urban design principles in existing developments as well as in news proposals; Theories & protocols of Urban Design -New Urbanism; Case studies of modern & contemporary urban interventions.

TEXT / REFERENCES:

- Broadbent, Geoffrey (1990). Emerging concepts in urban space design. Van Nostrand Reinhold, London.
- Christopher, Alexander. (198.7). New theory of urban design. Oxford University Press.
- Cullen, Gordon. (1968). Townscape. Architectural Press, London.
- Gallion Arthur B and Eisner, Simon. (1963). Urban Pattern : City Planning And Design. Van Nostrand Reinhold, London.
- Krier, Rob. (1984). Urban Space. Academy editions.
- Lynch, Kevin. (2000). Image of the city. MIT Press, London.
- Spreiregen, Paul D. (1965). Urban Design: The Architecture of Towns and Cities. McGraw Hill.

VI SEMESTER

ARCHITECTURAL DESIGN & DETAILING –STUDIO - VI

IAE 361 **2-6-0-8**

UNIT I- Theme & focus of design: Study & analysis of various latest technologies in large scale Architecture; Understanding, exploration & development of design programme, concept & detailed design with focus on Prefab.

UNIT II- Basic Components: Behavioral Science; Functionality; Building Materials; Theory of Design; Form Development; Tectonic decisions: Structures, Building Materials, Services; Site Planning; Building Control Regulations; Inclusive Design; Design Communication.

UNIT III- Non-linear Designs: Importance, Exploring & Understanding the essence; detailing process; User analysis; Elements; functionality, aesthetics; Materials. This Minor Exercise will be represented through conceptual development (sketches, physical & digital models).

UNIT IV- Design Analysis: Exploration & analysis of works of iconic High-tech Architecture; Understanding design philosophy & process; Learning from design quality, Literature/book reviews; Architectural critiques.

UNIT V- Design Exercise: Campus Design /Building Complex Design. Complexity of design: Large scale Institutional / Commercial / Industrial / Housing / Public use project of diversified activities with focus on horizontal & / or vertical circulation & grid planning. Typology: Campus, Housing, Institutions, Government complexes/offices, Multi-Level Car Park. Site extent: Upto 20000 m2.

TEXT / REFERENCES:

- Ching Francis. (1979). Architecture Form, Space and Order. Van Nostrand Reinhold Company, New York.
- Neufert Ernst. (1970). Architect's Data. Crosby Lockwood and Sons, London.
- Chiara JD and Calender. (1983). Time Savers Standards for Building Types. McGraw Hill Book Company, New York.
- Kolarevic, Branko. (2003., Architecture in the digital age: design and manufacturing. Taylor & Francis.
- Vesely, Dalibor. (2004). Architecture in the age of divided representation: the question of creativity in the shadow of production. MIT Press.
- BIS. (2005). The National Building Code of India, SP:7. Bureau of Indian Standards, New Delhi.
- BIS. (1987). Recommendations for Buildings and facilities for the Physically Handicapped. Bureau of Indian Standards.

STRUCTURAL & CONSTRUCTION SYSTEMS –STUDIO - VI

IAE 362 **2-2-2-5**

UNIT I- Introduction to Prefab: Types, Necessity, Advantages & disadvantages, Modular coordination: Grid systems, layout. Code provisions. Structural concepts with examples.

UNIT II- Precast Concrete: Types, Necessity, Code provisions. Structural concepts with examples. Introduction to pre-stressed concrete: Techniques, systems, Structural concepts.

UNIT III- Substructure & support system: Precast foundations, Types: slab, column, beams, Necessity, Code provisions. Structural concepts with examples, joinery details, transportation & erection.

UNIT IV- Roof & wall systems: Wall panels, roof systems, joinery details, transportation & erection.

UNIT V- Precast Components: stairs, toilets, doors, windows, furniture units, composites : Types, joinery details, transportation & erection; Dry wall construction.

TEXT / REFERENCES:

- Barry, Robin (1996),The construction of Buildings – Volume 4; Wiley Blackwell.
- Ryan E Smith (2011),Prefab Architecture: A Guide to Modular Design and Construction; John Wiley & Sons Publishing Company, United States
- IS 15916 (2011): Building Design and Erection Using Prefabricated Concrete - Code of Practice [CED 51: Planning, Housing and pre-fabricated construction], IS Code by Indian Standards Institution [ISI].
- IS:11447 (1985). Indian standard code of practice for construction with large panel prefabricates. IS Code by Indian Standards Institution [ISI].
- IS 15917 (2010): Building Design and Erection Using Mixed/Composite Construction - Code of practice, by Bureau of Indian Standards.

WORKING DRAWING & DETAILING – STUDIO - II

IAE 363 1-1-3-3

UNIT I- Staircase & its components.

UNIT II- Electrical layout with furniture; Circuit drawing; Conduit drawing; Voice & data; Fixture mounting heights etc.

UNIT III- Kitchen & Toilet details; Sanitary & plumbing; Rain water harvesting; water tank & septic tank as per calculations.

UNIT IV- Detailing of architectural elements. Door &window: Details, installation & hardware. Railing details. Wall finishes & colour scheme.

UNIT V- Site development details; Paving, Site drainage, compound wall, gate, etc.

Note: All Modules to include drawings & details; estimation & specifications.

TEXT / REFERENCES:

- Waktia, Osamu and Linde, Richard. (1977). The Professional Practice of Architectural Detailing. John Wiley and Sons, N.Y.
- Thomas, Marvin. (1978). Architectural Working Drawings: A Professional Technique. McGraw Hill Book Co., N.Y.
- Watila, A & Richard M.Linde. The Professional Practice of Architectural Working Drawings by Osamu. ISBN-10:0471395404, ISBN-13:978-0471395409.
- Gibbins EHH (1961), Introduction to Electrical Drawing, Blackie, London.
- Soni O.P. (1974), Electrical Engineering Design and Drawing; SatyaPrakashan, Delhi.

RESEARCH TECHNIQUES

IAE 364 **1-0-2-2**

UNIT I- Introduction to research: Domain of Architectural Research; Understanding the nature of research in architecture- Need & significance; Objectives; Characteristics; Ethics; Concepts of theory; Research methods in Architecture.

UNIT II- Research Process: Types of Research; Research methods & Research methodology; Research Process; Review of literature, research statement; Research design – need, components, considerations.

UNIT III- Data Collection & Sampling: Primary data; methods of data collection ; survey & observation; Questionnaires - types, aspects, sequence, Observation- types, characteristics, advantages, limitations etc., recording observations; Secondary data- sources, characteristics; Other Methods of Survey - visual, use of mechanical devices etc.; Sampling - need, significance, methods, classification, characteristics, determining sample size, time, event sampling etc.

UNIT IV- Data Analysis: Overview of measuring & scaling techniques; Processing & analysis of data - descriptive & inferential; graphical representation of analysis.

UNIT V- Report, Paper & proposal writing: Purpose, characteristics, guidelines, steps, format, structure, contents, presentation, referencing style, ethical issues: plagiarism etc.

TEXT / REFERENCES:

- Dwivedi, R.S. (2001). Research Methods in Behavioral Science. Mcmillan, New Delhi.
- Graziano, Anthon. (1989). Research Methods Process of Inquiry. Harper Collins Publishing New York.
- Groat, Linda and Wang, David. (2002). Architectural Research Methods. John Wiley publication, New York.
- Harrigan, J E. (1987). Human Factors Research Methods. Elsevier, Amsterdam.
- Kothari, C R. (1990). Research Methodology: Methods & Techniques, 2nd edn. Wishwa Prakashan, New Delhi.
- Sanhoff, Henry. (1991). Visual Research Methods in Design. Van Nostrand Reinhold, New York.
- Zeisel, John. (1995). Inquiry by Design: Tools for Environment-Behaviour Research. Cambridge University press, Cambridge.

CONTEMPORARY BUILT ENVIRONMENT

IAE 365 **1-0-2-2**

Detailed study & analysis of architectural design fundamentals through significant examples in the light of the following for the periods mentioned in the modules –

Genesis of seed ideas & concepts; Timeline; Socio-political background, key people involved; Climatic & geographic influence; General settlement pattern; Cities & its civic

places; Construction technology & material; Design principles; Typology; Evolution; Spatial organization; Form & Detailing.

The examples to represent the following historical styles are suggestive & students are encouraged to explore additional examples for a comprehensive understanding of the respective styles.

UNIT I- Industrial Revolution & Pre-Modern Era: Industrial Revolution & its impact on architecture; Great world expositions- London (1851)& Paris (1885); Chicago School of thought; Development of skyscraper – works of Louis Sullivan; Development of architectural theories- Arts & Crafts Movement; Art Noveau, Art Deco; Expressionism; De Stijl movement; Cubism; Organic Architecture & works of Frank Lloyd Wright & Antonio Gaudi; Works of other significant architects.

UNIT II- Modernism: Development of Rationalism & Functionalism; Bauhaus; Principles of Modernism; International style; Schools of thought; Ideas & works of Great Masters: Le-Corbusier, Walter Gropius, Mies Van Der Rohe, Frank Lloyd Wright, Alvar Alto, Oscar Niemeyer & others; Case studies from across the world

UNIT III- Post Independent India: Overview; Development of new state; Role of Government for infrastructure development; Influences of various movements & works of Great Masters- Le Corbusier, Louis Kahn, Joseph Allen Stein, Laurie Baker & Otto Koenigsberger; Language & works of first generation architects of Independent India - Achyut Kanvinde, CPWD & Habib Rahman, B.V. Doshi, Charles Correa, Raj Rewal, Anant Raje, Uttam C. Jain, Hansmukh Patel, Nari G&hi & others.

UNIT IV- Post Modern Era: Reaction to Modernism; Theory of Post Modernism & expression through significant works; impetus to other concurrent theories- Structuralism, Metabolism, Minimalism, Hi-Tech, Novelty, Critical Regionalism; Exploring principles of various theories through significant examples .

UNIT V- Contemporary Architecture: Current trends & theories in Architecture- Hi-Tech, De-constructivism, New Expressionism, Blobitecture, Green Architecture, Bionic Architecture; Design philosophies & works of contemporary architects; Case studies from across the world; Contemporary architecture in India.

TEXT / REFERENCES:

- Avery, Derek. (2003). Modern Architecture. Chaucer Press, London.
- Curtis, William J R. (2003). Modern Architecture since 1990, 3rd edition. Phaidon Press, London.
- Evans, Mike ed. (1998). Key Moments in Architecture. Hamlyn, London.
- Framption, Kenneth. (1992). Modern Architecture, a critical history, 3rd edn. London.
- Gossel, P. & Gabriele Leuthauser. (2001). Architecture in the twentieth century. Taschen, GmbH, Germany.
- Trachtenberg, Marvin & Hyman, Isabelle. (1986). Architecture from prehistory to post-modernism. Academy editions, London.
- Bhat, Vikram and Scriver, Peter. (1990). After The Masters. Mapin Publications, Ahmedabad.

- Jencks, Charles. (1984). The Language of Post Modern Architecture. Academy Editions, London.
- Krafft, Anthony. (1989). Contemporary Architecture. Biblothego Der Arts, France.
- Lang, Jon and others. (1997). Architecture and Independence. Oxford University Press, New Delhi.
- Venturi, Robert. (1977). Complexity and contradiction in architecture. Architectural Press Ltd. London.

PRINCIPLES OF HOUSING & ECONOMICS

IAE 366 **2-0-0-2**

UNIT I- Overview of housing : Concept of shelter, Timeline, Dynamics of housing- users, need, supply & dem&, providers, economic forces, terminologies; migration, urbanization, scale, scope, types & ownership; construction industry, current trends, realty sector.

UNIT II- Housing Issues: Significance in National Development; Urban & Rural housing in India: statistics, problems-slums, shortage etc., Issues, Challenges; Current scenario; Planning principles & policies; Dem&, Role of different institutions; Stake holder analysis, current typologies, appropriate housing requirements, best practices.

UNIT III- Housing legislations: National & State Housing Policy, Development control regulations, Acts & Bye laws, Strategies, Government & non-governmental agencies, Competent authorities, Schemes- PPP, SRA, Redevelopment, Sites & services etc.

UNIT IV- Housing Economics: Concepts, issues, aspects; Land & housing economics- valuation, rent, sinking fund, development cost; sources of finance, market characteristics, key constraints, Agencies & institutions, Real estate, Low cost housing, affordable housing; Incremental housing; housing finance in India – sources, characteristics, finance agencies.

UNIT V- Case Studies: Exploration & analysis of different housing schemes; Study of user profiles, provision, relevance, planning- physical, administrative, socio-cultural, sustainable, financial; future forecasts & trends.

TEXT / REFERENCES:

- K. Thomas Poulose- Innovative Approaches to Housing for the poor
- Dr. Misra and Dr.B.S. Bhooshan- HabitatAsia
- Dr. Misra and Dr.B.S. Bhooshan- Habitat India
- Arthur Gallion- Urban Pattern
- Reading Material in Housing -Compiled by K. Thomas Poulose for ITPI students
- Five Year Plans- Government of India Publications
- Websites of Government of India such as Ministry of Housing and Poverty Alleviation, Ministry of Housing and Urban Development, Ministry of Rural Development etc.

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