Mahindra École Centrale

Bahadurpally, Hyderabad 500043

ACADEMIC REGULATIONS FOR FOUR-YEAR UNDERGRADUATE DEGREE PROGRAMS

(Applicable to students from the Academic Year 2018-19 and onwards)

1) COURSES OF STUDY AND AWARD OF B. TECH. DEGREE

The Institute awards B-Tech degree in the following four four-year undergraduate (UG) programs:

S. No.	**B. Tech. Degree Program**
1	Civil Engineering
2	Computer Science and Engineering
3	Electrical Engineering
4	**Mechanical Engineering**

a) A student who has passed all the individual courses in the corresponding curriculum is entitled to be awarded the Bachelor of Technology (B. Tech.) degree provided he complies with the subsequent rules.

b) A student cannot be awarded the Bachelor of Technology (B. Tech.) degree with a Cumulative Performance Index (CPI) strictly less than 4.0.

c) A student must not earn not less than 165 credits (see b)) for the award of the B-Tech. degree.

d) A student after securing admission into one of the four B. Tech. degree programs must pursue the course of study for a duration of 8 semesters (or 4 years). Each semester shall have a minimum of 90 days of instruction including Examinations, as per AICTE norms. The B. Tech. degree program has to be completed within at most 8 consecutive years from the date of admission to the program.

e) The first two years of the B. Tech. degree program are termed as the Core Program and the last two as the Professional Program. The maximum duration to complete all academic requirements of either the Core or the Professional Program is four consecutive years from the year of the

registration into the corresponding program; students who fail to do so shall forfeit their seats in the B. Tech. course.

f) Elective courses are available in the professional program. Students in consultation with faculty members may propose their choices from among the offered elective courses; the proposal needs approval by a departmental committee nominated by the Dean of Academics.

g) Cancellation of Admission: All students admitted provisionally or otherwise to any program shall submit copies of their mark sheets, provisional certificates, etc. of the qualifying examination and other documents by the last date specified for the purpose in the Academic Calendar. MEC reserves the right to cancel the admission at any later time if it is found that the student had supplied false information or suppressed relevant information while seeking admission.

h) Any matter relating to the award of the B. Tech. degree that is not covered in the existing regulations is to be decided upon by a standing committee (nominated by the Director) composed of faculty members and chaired by the Dean Academics.

2) CREDITS AND ACADEMIC PERFORMANCE

a) Credit representation: Each lecture hour contributes to *one credit*, while one hour of tutorial or practical contributes toward *half a credit*.

No. of lecture hours per week	No. of tutorial hours per week	No. of practical hours per week	Total credits
2	1	2	2*1 + 1*0.5 + 2*0.5 = 3.5

b) Grades and Grade Points: At the end of the semester, a student is awarded a letter grade (based on a prescribed process) in each of his courses by the concerned Instructor-in-Charge taking into account his performance in the various examinations, quizzes, assignments, laboratory work (if any), etc., besides regularity of attendance in classes. The grades are submitted in the undergraduate office within the prescribed time limit of 72 hours after the end semester examination. There are eight letter grades: A, B^+, B, C^+, C, D, E and F. The letter grades and their numerical equivalents on a 10-point scale (called Grade Points) are as follows. The letter grades: A, B^+, B, C^+, C and D are considered as passing grades; students who are awarded any of these grades in a course, acquire the corresponding number of credits allotted to the

course. The letter grades: E and F are considered as failing grades; students who are awarded any of these grades in a course, do not acquire the corresponding number of credits allotted to the course; such students have to take up a supplementary examination to get a passing grade.

Letter Grades	A	B^+	B	C^+	C	D	E	F
Grade Points	10	9	8	7	6	4	2	0

In addition to the letter grades mentioned above, there is an additional letter grade, viz., 'I' which stands for Incomplete. A student may be awarded the grade 'I' (Incomplete) in a course if he has missed, for a genuine reason such as a medical reason, as decided by the instructor in charge or the Dean Academics, , a part of the course requirement but has done satisfactorily in all other parts.. An 'I' grade must, however, be converted by the Instructor-in Charge into an appropriate letter grade and communicated to the undergraduate office by the last date specified in the academic calendar. Any outstanding 'I' grade after this date shall be automatically converted into the 'F' grade.

c) Project Grades: Project grades shall be submitted by the last date specified for the submission of grades. An 'I' grade may be given only on medical grounds or by recommendation of the project evaluation committee to the Dean Academics.

d) Change of Grade: A letter grade once awarded shall not be changed unless the request made by either the Instructor-in-Charge of the course is approved by the Dean Academics. However, any such request for change of grade must be made within six weeks of the start of the next semester in the prescribed form with all relevant records and justification.

e) Semester Performance Index (SPI): The Semester Performance Index (SPI) is a weighted average of the grade points earned by a student in all the courses credited and describes his/her academic performance in a semester. If the grade points associated with the letter grades awarded to a student are g1, g2, g3, g4, and g5 in five courses and the corresponding credits are c1, c2, c3, c4, and c5, the SPI is given by:

$$\text{SPI} = \frac{c1g1+c2g2+c3g3+c4g4+c5g5}{c1+c2+c3+c4+c5}$$

f) Cumulative Performance Index (CPI): The Cumulative Performance Index (CPI) indicates the overall academic performance of a student and is computed in the same manner as SPI by considering the grades in all the courses registered

up to and including the most recently completed semester/summer term. When a student is permitted to repeat or substitute a course/examination, the new letter grade replaces the old letter grade in the computation of CPI; however, the previous grades remain in the Grade Report.

g) Grade Report: A copy of the Grade Report is issued to each student at the end of the semester. A duplicate copy, if required, may be obtained on payment of a prescribed fee.

CPI, SPI condition ?

3) DISTRIBUTION AND WEIGHTAGE OF MARKS

a) The performance of a student in each course of a semester shall be evaluated out of a possible maximum of 100 marks. The resulting marks will then be converted to appropriate letter grade.

b) Specifics of breakup of marks shall be defined at course level. This breakup of marks will be communicated by the instructor in charge at the beginning of the semester. The below-mentioned guidelines shall be followed:

    i. The distribution of marks for all courses shall follow the principles of continuous evaluation. Continuous evaluation during the semester – through mid-term examinations, quizzes, assignments, team projects, term papers, seminars, presentations, etc., (whichever of them applicable for a particular course) – typically constitute between 40-50% of the total marks, whereas, the end-semester examination including lab will constitute 50-60% of the marks.

    ii. For courses without a laboratory, there shall be at least one mid-semester examination along with any other forms of continuous evaluation methods described above (i.). The first mid-semester examinations shall cover units taught during the first spell of instructions i.e. from the beginning of the semester until the first mid-semester examination. A second mid-semester examination if any shall cover the units taught during the second spell of instructions i.e. the intervening period between first mid-semester examinations and the second mid-semester examinations. The end-semester examination will cover all the units taught during the entire semester. All end-semester examinations shall be for a total of 100 marks.

    iii. For courses consisting of both theoretical and laboratory

components or design or drawing or project (such as but not limited to Engineering Graphics, Engineering Drawing, Machine Drawing) as a part of the course, the evaluation process for the theory part shall follow the same procedure as described above, with typically a total marks for theory between 60-70 (out of the maximum of 100) and the rest of 30-40 marks being awarded to the laboratory part. The evaluation of the laboratory/practical part of the course shall also follow the principle of continuous evaluation. The instructor-in-charge shall inform the students whether an independent minimum passing mark in the theory part of the course as well as an independent minimum passing mark in the laboratory part of the course is required.

b) There shall be an industry-internship, in collaboration with industry/academia, to be taken up before the beginning of the 4^{th} year. The evaluation of the internship shall be based on the performance evaluation report from the industrial/academic partner and may be a viva. There shall be no credits awarded for the internship.

c) Project beginning during the first semester of academic year III may extend over the second semester. Provisional grade will be awarded at the end of the first phase of the project and upon successful completion of the project this grade is subject to revision at the end of the second phase. For each semester it shall be evaluated for a total of 100 marks. The evaluation shall be based on the report submitted at the end of the project and the presentation of the project to a committee. The committee shall consist of the supervisor of the team project and another faculty member of relevant experience.

d) B. Tech project shall begin in IV year I semester (phase-I) and will continue during IV year II semester (phase-II). Out of the total 100 marks for the project work, 25 marks shall be allotted for internal evaluation and 75 marks for final project report and end semester examination (viva voce). The end semester examination of the project work shall be conducted by an expert committee consisting of at least two faculty members with relevant subject specialization. In addition, the project supervisor shall also be a member of the committee. Evaluation of the progress of the project shall be done one at the end of the first phase (semester) and a provisional grade is awarded. Upon successful completion of the project evaluation process a revised grade for both first and second phase shall be awarded.

4) ATTENDANCE REQUIREMENTS

a) A student shall be eligible to receive a passing grade in a course offered in a specific semester, if he acquires a minimum of 75 % attendance in lectures, tutorials and lab individually in that course during the same semester.

b) A student with up to 10% of shortage of attendance in a course (an attendance of at least 65%) in a semester may apply to the Dean of Academics; such exceptions shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence, and on payment of a stipulated fee.

c) A student with attendance below 65% in a course in a semester could be condoned on a case by case basis at the discretion of the Director; such exceptions shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence, and on payment of a stipulated fee.

d) A student with attendance below 75% in a course during a semester, who has not been exempted by the Dean of Academics, will receive an F grade by default in the corresponding course.

5) ACADEMIC PROGRESSION REQUIREMENTS

a) The Student Performance Committee, chaired by the Dean of Academic Affairs informs and advises students on their academic performance.

b) The Student Performance Committee, gives their recommendation to the director on the academic progression of all admitted students.

c) A student completing an academic year (N) may be promoted to the next academic year (N+1) when he has acquired at least:

- 60% of the credits in the current academic year (N)
- 90% of the credits in all previous academic years (<N)

d) Students who receive failing grades in courses are permitted to avail supplementary examinations for those courses. With the permission of the SPC students may also be allowed to take up these courses with extra-load during a regular semester.

e) When a student in any given semester acquires at least 60% of the credits prescribed during that semester, he may be permitted to take up the full

course load during the next semester; otherwise, the student may be advised to take up a reduced course load.

f) Marks obtained in a supplementary examination will be used to re-compute the grade in the corresponding course. However, the supplementary examination may replace either the end-semester or both the end-semester and mid-semester examination-components (whichever is more beneficial to the student) of the total marks and no other evaluations like the laboratory component or projects, assignments, etc.

6) WITHHOLDING OF RESULTS

If the student has not paid dues, if any, to the Institute or if any case of indiscipline is pending against him, the result of the student will be withheld and he will not be allowed into the next semester and/or his degree will be withheld.

7) TRANSITORY REGULATIONS

a) Students of previous batches may be given equivalent subjects as per the revised regulations, which they have to pass in order to obtain the required number of credits.

8) GENERAL

a) Wherever the words "he", "him", "his", occur in the regulations, they include "she", "her", "hers".

b) The academic regulations should be read as a whole for the purpose of any interpretation.

c) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Director is final.

d) The Institute may change or amend the academic regulations or syllabi from time to time and the changes or amendments made shall be applicable to all the students with effect from the corresponding notification date.

COURSE CATEGORIES

S. No.	Category	Description
1	CB – Chemistry and Biology	Courses in Chemistry and Biology.
2	CE – Civil Engineering	Courses related to Civil Engineering
3	CS – Computer Science	Courses in Computer Science and Technology
4	EE – Electrical Engineering	Courses of Electrical Engineering
5	ES – Engineering Sciences	Basic Engineering Courses
6	ME – Mechanical Engineering	Courses in Mechanical Engineering
7	HS – Humanities and Social Sciences	Courses in Language, Culture, Philosophy, etc.
8	SE – Society & Enterprise	Includes projects and courses in Media, Industrial Engineering, Management, Finance, etc.

Semester 1						
	Code	**Course**	**L**	**T**	**P**	**Credits**
1	MA 101	Mathematics - I	4	1	0	5
2	CH 101	Chemistry - I	2	1	0	3
3	ES 101	Introduction to Electrical Engineering	2	1	2	4
4	ES 102	Engineering Drawing	0	0	3	1.5
5	ES 103	Earth and Environmental Sciences	2	0	0	2
6	ES 104	Thermodynamics	2	1	0	3
7	SE 101	Media Project	0	0	3	1.5
8	HS 101	English and Humanities - I	1	2	2	4
9	FL 101	French Language & Culture - I	0	2	0	0
						24

Semester 2						
	Code	**Course**	**L**	**T**	**P**	**Credits**
1	MA 102	Mathematics - II	3	1	0	4
2	PH 101	Physics - I	2	1	2	4
3	CH 102	Chemistry - II	2	0	2	3
4	ES 105	Electronics	2	1	2	4
5	ES 106	Introduction to Computer Science	2	1	2	4
6	ES 107	Workshop Practice	0	0	2	0
7	SE 102	Introduction to Enterprises & Economy	2	1	0	3
8	HS 102	Professional Ethics	0	1	0	1
9	FL 102	French Language & Culture - II	0	2	0	0
						23

Semester 3						
	Code	**Course**	**L**	**T**	**P**	**Credits**
1	MA 203	Mathematics - III	3	1	0	4
2	PH 202	Physics - II	3	1	2	5
3	ES 208	Mechanics	2	1	0	3
4	ES 209	Signals & Systems	3	1	0	4
5	ES 210	Data Structures	2	2	2	5
6	ME 201	Computer Aided Engineering Design	1	0	4	3
7	FL 203	French Language & Culture - III	0	2	0	0
						24

Semester 4						
	Code	**Course**	**L**	**T**	**P**	**Credits**
1	ES 211	Numerical Methods	3	0	2	4
2	ME 202	Transport Phenomena	3	1	0	4
3	ME 203	Manufacturing Processes I	3	0	0	3
4	ME 204	Mechanics of Solids	2	1	0	3
5	ME 205	Theory of Mechanisms and Machines	2	1	2	4
6	SE 203	Design Thinking	1	0	2	2
7	FL 204	French Language & Culture - IV	0	2	0	0
						20

Semester 5						
	Code	**Course**	**L**	**T**	**P**	**Credits**
1	MA 304	Mathematics - IV	3	1	0	4
2	ES 312	Introduction to Materials Sciences	2	0	2	3
3	ME 306	Manufacturing Processes II	2	1	2	4
4	ME 307	Applied Fluid Dynamics and Heat Transfer	3	1	0	4
5	ME 308	Design of Machine Elements	3	1	0	4
6	ME 309	Experimental Analysis	0	0	4	2
7	HS-E1	HSS + Mgmt. - Elective - I	2	0	0	2
8	FL 305	French Language & Culture - V	0	2	0	0
						23

Semester 6						
	Code	**Course**	**L**	**T**	**P**	**Credits**
1	ME 310	Multiphysics	3	1	0	4
2	ME 311	Thermal Engineering	3	1	0	4
3	ME 312	Finite Element Methods	3	0	2	4
4	ME 313	Structural Dynamics and Acoustics	3	1	0	4
5	PR 301	Third Year Project	0	0	6	3
6	HS-E2	HSS + Mgmt. - Elective - II	2	0	0	2
7	E1	Elective - I	3	0	0	3
8	FL 306	French Language & Culture - VI	0	2	0	0
						24

Semester 7						
	Code	**Course**	**L**	**T**	**P**	**Credits**
1	ME 414	Control Theory	3	0	0	3
2	ME 415	Industrial Engineering	3	0	0	3
3	HS-E3	HSS + Mgmt. - Elective - III	2	0	0	2
4	E2	Elective - II	3	0	0	3
5	E3	Elective - III	3	0	0	3
6	PR 402	Year-4 Project	0	1	4	3
7	FL 407	French Language & Culture - VII	0	2	0	0
						17

Semester 8						
	Code	**Course**	**L**	**T**	**P**	**Credits**
1	E4	Elective - IV	3	0	0	3
2	E5	Elective - V	3	0	0	3
3	PR 403	Year-4 Project	0	5	8	9
4	FL 408	French Language & Culture - VIII	0	2	0	0
						15

List of Electives: Semesters 6, 7, & 8						
S.No.	**Code**	**Course**	**L**	**T**	**P**	**Credits**
1	ME 450	Refrigeration & Air Conditioning	3	0	0	3
2	ME 451	Advanced Manufacturing	3	0	0	3
3	ME 452	Introduction to Operations Research	3	0	0	3
4	ME 453	Dynamics and Applications	3	0	0	3
5	ME 454	Theory of Mechanisms and Machines	3	0	0	3
6	ME 455	Turbomachinery	3	0	0	3
7	ME 456	Systems Engineering	3	0	0	3
8	ME 457	Advanced Mechanics of Materials	3	0	0	3
9	ME 458	Introduction to IC Engines	3	0	0	3
10	ME 459	Power Plant Engineering	3	0	0	3
11	ME 460	Alternative Energy Sources	3	0	0	3
12	ME 462	Composite Materials	3	0	0	3
13	ME 463	Engineering Alloys in Design	3	0	0	3
14	ME 465	Flight Dynamics	3	0	0	3
15	ME 466	Aircraft Design	3	0	0	3
16	ME 467	Introduction to Robotics	3	0	0	3
17	ME 468	Introduction to Combustion	3	0	0	3
18	ME 469	Computational Fluid Dynamics	3	0	0	3
19	ME 470	Robotics: Dynamics and Control	3	0	0	3
20	ME 471	Micro-scale Mechanics	3	0	0	3
21	ME 472	Theory of Elasticity	3	0	0	3

22	CB 304	Chemical & Bio Engineering	3	0	0	3
23	CE 312	Environmental Engineering	3	0	0	3
23	CE 470	Application of Soil Mechanics	3	0	0	3
24	CS 313	Machine Learning	2	0	2	3
25	CS 452	Advanced Data Analytics	3	0	0	3
26	CS 456	Social Computing	3	0	0	3
27	CS 457	Deep Learning	3	0	0	3
28	CS 458	Information Retrieval and Natural Language Processing	3	0	0	3
29	CS 461	High Performance Computing	3	0	0	3
30	EE 451	Information Theory and Coding	3	0	0	3
31	EE 471	Digital Image Processing	3	0	0	3
32	EE 472	Computer Vision	3	0	0	3
33	EE 475	Biomedical Signal Processing	3	0	0	3
34	EE 476	Microwave Engineering	3	0	0	3
35	EE 477	Computational Electromagnetics	3	0	0	3
36	EE 480	Neuroscience and Anatomy	3	0	0	3
37	EE 481	Neural Networks and Sensors	3	0	0	3
38	EE 482	Signal Processing in Neural Systems	3	0	0	3
39	EE 483	Brain Modelling and ANNs	3	0	0	3
40	EE 485	IoT System Architecture and Design	3	0	0	3
41	EE 486	Sensors and Instrumentation	3	0	0	3
42	EE 487	High Performance Embedded Systems	3	0	0	3
43	MA 450	Numerical Linear Algebra	3	0	0	3

44	MA 451	Meshfree Methods	3	0	0	3
45	MA 452	Boundary Element Method and Boundary Integral Equations	3	0	0	3
46	MA 453	PDE Based Image Processing	3	0	0	3
47	MA 454	Topology and Operator Theory	3	0	0	3
48	MA 455	Infinite Dimensional Control Theory	3	0	0	3
49	MA 456	Bayesian Statistics	3	0	0	3
50	MA 457	Financial Mathematics	3	0	0	3
51	MA 458	Nonlinear Conservation Laws and Applications	3	0	0	3
52	PH 304	Physics IV	3	0	0	3
53	PH 451	Lasers: Principles and Applications	3	0	0	3

List of HS Electives: Semesters 5, 6 & 7						
S.No.	**Code**	**Course**	**L**	**T**	**P**	**Credits**
1	HS 500	Selections from World Literature	2	0	0	2
2	HS 501	Business Communication	2	0	0	2
3	HS 502	Visual Story Telling	2	0	0	2
4	HS 503	Introduction to Culture Studies	2	0	0	2
5	HS 504	Literature and Visual Arts	2	0	0	2
6	HS 505	Cinema and Philosophy	2	0	0	2
7	HS 506	The Humanities for a Critical Understanding of the World	2	0	0	2
8	HS 507	Academic Writing	2	0	0	2
9	HS 508	Urban Studies: Reading the City	2	0	0	2
10	HS 509	Contemporary Shakespeare: Readings and Adaptations	2	0	0	2
11	HS 510	Philosophical Arguments	2	0	0	2

Course Code: **MA 101**
Course Name: **Mathematics - I**
Credits: **5 (4-1-0)**
Course Position: **Semester 1**

Course Content:

1. Single variable calculus
Limit, Continuity, Integration and its Applications, Polar Coordinates, Differentiability, Applications of Differentiation, Mean value theorem and its Applications, Curve Sketching, Indeterminate Forms, Taylor's and Maclaurin's theorems, Fundamental Theorem of Calculus.

2. Functions of Several Variables
Limit, Continuity, Total Differential, Extrema of functions, Lagrange multiplier method, Double and Triple integrals, Change of Order of Integration.

3. Vector Calculus
Gradient, Divergence and Curl, Line, Surface and Volume Integrals, Theorems of Green, Stokes and Gauss and their applications.

4. Infinite Series
Sequences, Convergence and Divergence of a series, Tests for Convergence, Conditional and Absolute Convergence, **uniform convergence of sequence of functions.**

5. Ordinary Differential Equations: The existence and uniqueness theorem on the general first order differential equations (statement, without proof, with some simple examples). Variable separable method, reducible to variable separable. Exact differentiable equations, integrating factors. Linear differential equations, Bernoulli's equation. The general solution of the second order linear homogeneous equations with constant coefficients. Undetermined coefficients, Variation of parameters. Cauchy problem for differential equation systems. Existence theorem (without proof), differential linear systems with constant coefficients. Geometric study in phase plane of simple equations, orthogonal polynomials.

Text and Reference Books

- Tom M. Apostol, One Variable Calculus, with an Introduction to Linear Algebra (Text Book for First, Second and Fifth Modules)
- Tom M. Apostol, Multi-Variable Calculus and Linear Algebra, with Applications to Differential Equations and Probability (Text Book for Third and Fourth Modules)
- R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications (Reference Book)
- E. Kreyszig, Advanced engineering mathematics, John Wiley (1999).
- George B. Thomas, Jr., Maurice D. Weir, Joel Hass, Thomas' Calculus
- W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005).

Course Code: **CH 101**
Course Name: **Chemistry**
Credits: **3 (2-1-0)**
Course Position: **Semester 1**

Objectives:

The objective of the course is to let the students understand basic chemistry and the relevance to engineering. Basic concepts of physical and analytical chemistry will be introduced in the lectures to develop their intuitive understanding of natural effects.

Course Content:

Module – 1: Atomic structure and periodic properties (6 lectures): Wave-particle duality. Schrodinger equation. Principles of quantum mechanics. Particle in a one-dimensional box solutions and its applications. Hydrogen atom wave functions. Shape and size of atomic orbitals. Multi-electron atoms – shielding – effective nuclear charge – orbital penetration. Periodic table and periodic properties of elements: electronic configuration, ionization energy and electron affinity.

Module – 2: Chemical bonding and intermolecular interactions (8 lectures): Molecular orbitals as linear combinations of atomic orbitals. Molecular orbital energy level diagrams of homonuclear and heteronuclear diatomic molecules - electronegativity. Multi-atomic molecules, molecular geometry and symmetry. Crystal field theory of transition metal ions. Band theory of solids. Molecular properties: Dipole moment and Polarizability. Intermolecular interactions: dipolar and van der Waal's interactions.

Module – 3: Analytical methods (10 lectures): Theoretical background of UV-Visible Spectroscopy, Infrared and Raman spectroscopy, Microwave spectroscopy, NMR spectroscopy and magnetic resonance imaging. Introduction to surface analytical techniques: X-ray photoelectron Spectroscopy, Atomic force microscopy.

Module – 4: Structure determination using spectroscopic methods (6 lectures): Introduction to chemical analysis of organic molecules. Elemental analysis and Mass spectrometry. Structural elucidation of simple organic molecules using combination of different spectroscopic data.

Text / Reference Books

- Atkin's Physical Chemistry; 10th edition; Peter Atkins and Julio De Paula; ISBN 978-0-19-954337-3
- Fundamentals of Molecular Spectroscopy; 4th edition; Colin N. Banwell and Elaine M. McCash; ISBN-13: 978-9352601738
- Organic Spectroscopy; 3rd Edition; William Kemp; ISBN 978-1-4039-0684-7

Course Code: **ES 101**
Course Name: **Introduction to Electrical Engineering**
Credits: **4 (2-1-2)**
Course Position: **Semester 1**

Course Content:

Module 1: Electrical Quantities and Circuit Elements; Circuit Analysis: nodal and mesh analyses, superposition and linearity, network simplification;

Module 2: Network Graphs: nodal analysis using reduced incidence matrix, mesh analysis using fundamental circuit matrix, Tellegen's theorem;

Module 3: Sinusoidal Steady-State Analysis: nodal and mesh analyses using phasor method, Thevenin's theorem, maximum-power conditions; Response to Simple Networks: forced, natural and total responses in RLC networks;

Module 4: State Equations: zero-state, zero-input and total responses in RLC networks; Network Functions: poles, zeros and their properties;

Module 5: Resonant Circuits; Two-Port Networks: impedance, admittance and hybrid parameters; Magnetic Circuits and Transformers.

Textbooks:

1. E. Fitzgerald, D. E. Higginbotham, A. Grabel; Basic Electrical Engineering; Fifth Edition, McGraw-Hill, 2009.
2. A. Desoer, E. S. Kuh; Basic Circuit Theory; Tata McGraw-Hill, 2009.
3. M. E. Van Valkenburg; Network Analysis; Third Edition, PHI Learning, 1980.

Course Code: **ES 102**
Course Name: **Engineering Drawing**
Credits: **1.5 (0-0-3)**
Course Position: **Semester 1**

Module-1 : General principles, projection systems and multiview drawing
Sizes of drawing sheets, layouts, scales, lines, and lettering. The multiview projection method:
orthographic representations including first and third angle projections. Projection symbols.

Module -2: Pictorial drawing
Isometric projection. Isometric drawing / isometric view. Oblique projections: cavalier view, and
cabinet view.

Module-3 : Sectioning
The cutting plane and its line type. The viewing direction. Naming the sectional view. Hatching of internal surfaces contacting the cutting plane. Convention for hidden features below the cutting plane. Half sections. Offset sections. Revolved sections, removed sections, local sections, and successive sections. Conventions on not hatching shafts, ribs, keys, fasteners, and spokes of wheels.

Module-4 : Computer aided drafting
Practical training on the basics of computer aided drafting using commercial software.

Module-5 : Dimensioning, tolerancing, annotations, and conventions
Distinction between functional, non-functional, and auxiliary dimensions.
Elements of dimensioning: projection lines (extension lines), dimension lines, and leader lines. Types of termination of dimension lines, and origin indication.
Placing of dimensions: the aligned and the unidirectional systems. Shape indication, e.g., diameters, radii, etc.
Special indications: chords, arcs, and angles.
Arrangement of dimensions: Chain dimensioning, and dimensioning from a common feature. Tolerance stack-up in chain dimensioning. Simplified representations of intersections. Representations of square ends. Views of symmetrical parts. Simplified views of repetitive features.

Reference Text Book:

1. Engineering Drawing by N. D. Bhatt, Charotar Publishing House Pvt. Ltd., Anand, 2012 Reprint.

Course Code: **ES 103**
Course Name: **Earth and Environmental Sciences**
Credits: **2 (2-0-0)**
Course Position: **Semester I**

Course Content:

Module 1: The earth system: Earth in the solar system. Atmosphere and oceans: Origin and evolution; Atmosphere-ocean interaction; Air pollution, Greenhouse effect, Ozone layer; Ocean currents and waves. Lithosphere, Hydrosphere, Cryosphere and atmosphere and their Interactions.

Module 2: Environment and Environmental Studies:

Definition and Components of Environment, Relationship between the different components of Environment, Man and Environment relationship, Impact of technology on Environment, Environmental Degradation, Multidisciplinary nature of the Environment studies, its scope and importance in the present day Education System

Module 3: Ecology and Ecosystems:

Introduction: Ecology- Objectives and Classification, Concept of an ecosystem- structure and functions of ecosystem, Components of ecosystem- Producers, Consumers, Decomposers. Bio-Geo- Chemical Cycles- Hydrologic Cycle, Ocean currents and waves. Lithosphere, Hydrosphere, Cryosphere and atmosphere and their Interactions, Carbon cycle, Energy Flow in Ecosystem, Food Chains, Food webs, Ecological Pyramids Major Ecosystems: Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem, Estuarine Ecosystem.

Module 4: Population and Economic Growth: The nature of human population growth, population parameters, industrialisation, urbanisation, sustainable development, sustainable consumption, health and the environmental impacts.
Environmental pollution: Types of Environmental Pollution: Water Pollution: Introduction – Water Quality Standards, Sources of Water Pollution: Industrial Agricultural, Municipal; Classification of water pollutants, Effects of water pollutants, Eutrophication Marine pollution- Air Pollution: Composition of air, Structure of atmosphere, Ambient Air Quality Standards, Classification of air pollutants, Sources of common air pollutants like PM, SO_2, NO_X, Natural & Anthropogenic Sources, Effects of common air pollutants Land Pollution: Land uses Land degradation: causes, effects and control, soil erosion
Noise Pollution: Introduction, Sound and Noise, Noise measurements, Causes and Effects Thermal Pollution: Causes and effects, Role of individual in the prevention of pollution

Module 5: Social Issues and the Environment: From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water

harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization. Environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, and ozone layer depletion, nuclear accidents and holocaust, case studies. Wasteland reclamation – consumerism and waste products. Environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

Text Book:

- The Good Earth: Introduction to Earth Science. 2nd Edition, McConnell, Steer, Knight, Owens & Park (2010), McGraw-Hill, New York, USA.
- Geology for Geotechnical Engineers, J.C. Harvey, Cambridge University Press
- Basics of Environmental Studies, Varandani, LAP -Lambert Academic Publishing , Germany.
- Basics of Environmental Studies U K Khare, 2011 ,Tata McGraw Hill
- Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.

References:

- Dharmendra S. Sengar, 'Environmental law', Prentice hall of India Pvt Ltd, New Delhi, 2007.
- Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) Pvt, Ltd, Hydrabad, 2015.
- G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.
- The Good Earth: Introduction to Earth Science. 2nd Edition, McConnell, Steer, Knight, Owens & Park (2010), McGraw-Hill, New York, USA.

Course Code: **ES 104**
Course Name: **Thermodynamics**
Credits: **3 (2-1-0)**
Course position: **Semester 1**

Course Content:

Module 1: Introductory Concepts and Definitions

System and Surroundings, Macroscopic and Microscopic approaches, Intensive and Extensive Properties, Path and Process, Thermodynamic Equilibrium, Zeroth Law.

Module 2: First Law of Thermodynamics

Closed and Open Systems, Energy, Heat and Work, First law for closed system and flow process, Applications of First law.

Module 3: Properties of Pure Substances

Properties of gases Pure substance, Liquid, Solid, and Vapour Phase Properties, Triple Point, Critical Point, Dryness Fraction, use of Vapour Tables, Mollier Chart.

Module 4: Second Law of Thermodynamics

Clausius and Kelvin-Planck Statements, Heat Engines and Heat Pumps, Reversibility, Carnot Efficiency, Entropy, Availability and Irreversibility

Module 5: Basics of Energy Conversion Cycles

Carnot Cycle, Air-Standard Cycles, Mean Effective Pressure, Vapour Power Cycles, Refrigeration Cycle, Vapour Compression Cycle

Reference text books:

- P.K. Nag, “Engineering Thermodynamics”, McGraw Hill, New Delhi
- Van Wylen, “Engineering Thermodynamics”, Wiley
- Cengel, “Thermodynamics - An Engineering Approach”, Tata McGraw Hill, New Delhi
- Moran and Shapiro, Principles of Engineering Thermodynamics”, John Wiley & Sons

Course code: **SE 101**
Course Name: **Media Project**
Credits: **1.5 (0-0-3)**
Course Position: **Semester 1**

Module-1 (2 weeks) : Introduction to Image : properties ,elements , technology of imaging.

LAB: sketching images, 5 hand drawn images leading to a comic strip, uses of color for the images, INSTAGRAM usage for capturing images.

Module -2 (4 weeks): Visual Design, Visual and Aural Story telling

LAB: Introduction to Camera, Microphones, Report writing, Editing software

Module-3 (2 weeks): Introduction to moving images ,building up a narrative .

LAB: Advance training in camera handling, sound recording, dealing with real life situations, editing to form a narrative with actual footage and writing scripts.

Module-4 (4 weeks) : Production of a 30 to 45 second narrative, using various images set to a pre-recorded audio track in real life situations, dealing with challenges, start of postproduction of documentaries.

Module-5 (4 weeks): Post Production: Editing of the raw footage to form a structured narrative, dealing with sound and music to enhance the narrative and finalizing the project.

Discussing the learning outcomes from the project.

Course Code: **HS 101**
Course Name: **English and Humanities – I**
Credits: **4 (1-2-2)**
Course Position: **Semester 1**

Theory Component:

Module I

1. The Bet- Anton Chekhov
2. Seven Ages of Man/ To be or not to be/ Mark Antony's Speech in Julius Caesar- William Shakespeare
3. *London*- William Wordsworth; *Ode on a Grecian Urn*- John Keats

Skills: Paragraph Writing: types, structure, features; Topic, supporting and concluding sentences; Definition, Description, Illustration; Concord.

Module II

1. *Ulysses*- Tennyson
2. *The Second Coming*- W. B. Yeats
3. Destructors- Graham Greene

Skills: Expository and Argumentative writing, Fact versus Opinion, Connectors, Noun and Adverbial clauses

Module III

1. A Homemade Education: Malcom X
2. I have a Dream: Martin Luther King OR "The Meaning of July Fourth for the Negro" by Frederick Douglas
3. The Danger of a Single Story- Chimamanda Adichie

Skills: Essay – Structure, organisation, unity, coherence, cohesion; Developing the thesis; Narrative essay; Active/Passive voice

Module IV

1. Wife's Letter- Rabindranath Tagore
2. Toba Tek Singh- Sadat Hassan Manto
3. Imaginary Homelands- Salman Rushdie

Skills: Close reading and Comprehension; Compare/Contrast and Cause and Effect Essays; Conditionals

Module V

1. *Where I live*- Arundhathi Subramaniam
2. Dance Like a Man- Mahesh Dattani

Skills: Process Analysis Essay; Summarizing; Translation (from Indian language to English)

Lab Component: Phonetics & Communication Skills practice cycles (14 weeks):

I. Introduction to Phonetics: Phonetics- a branch of Linguistics, International Phonetic Alphabet (IPA), Phonetic Symbols, English as an international language.

Introduction: Introduction to effective communication, verbal/non-verbal aspects of communication, components of communication, introducing oneself and others

II. Sounds of English: Classification of English phonic sounds into Vowels and Consonants, Description and Characteristic features

Situational Dialogues: Role plays, greeting, making requests, seeking permissions, asking for and giving instructions/directions, turn taking, telephone etiquette.

III. Vowels: Classification, Description, Articulation, Acoustics, Prosody and Transcription.

Debates: Stating points of view, agreeing/disagreeing, asking for and giving information, negotiation and persuasion, making suggestions.

IV. Consonants: Classification, Description, Articulation, Acoustics, Prosody and Transcription

Presentation Skills: Individual/group presentations, poster presentations, PowerPoint presentations, describing and interpreting non-verbal data, project reports/proposals.

V. Stress Patterns: Syllable, Word Stress, Stress Patterns

Group Discussion: Team dynamics, techniques for group discussions, intervention, turn taking, summarizing, body language, tone, relevance, fluency and coherence.

VI. Intonation: Rising intonation, Falling intonation and Rise- Fall intonation

Panel Discussion: Initiating and coordinating discussion, asking for and expressing opinions, providing clarification, coordinating, conducting and participating in meetings.

VII. Rhythm: Stressed-time language, Connected speech, Pitch

Public Speaking: Structure, organizing thoughts/ideas, effective transitions, summarizing and concluding, body language, tone, JAM sessions.

Course code: **FL 101**
Course Name: **French Language and Culture - I**
Credits: **0 (0-2-0)**
Course Position: **Semester 1**

Objectives:

To develop basic LSRW skills in French Language, from learning how to pronounce and write French alphabet to picking up phrases and words in written, spoken communication through listening and reading exercises.

Course Content:

A) Topics

- Alphabet
- Numbers
- Nationality
- Profession
- Country and Cities
- Self-introduction and introducing others

B) Grammar

- Present tense only with 1st group regular and irregular verbs
- Negations
- Prepositions in front of countries and cities
- Likes and dislikes with simple notions

C) Types of writing

- Very short essay on introduce oneself

Course Code: **MA 102**
Course Name: **Mathematics – II**
Credits: **4 (3-1-0)**
Course Position: **Semester 2**

Course Content:

1. **Linear Algebra:** Real and complex vector spaces, Linear dependence, Matrix of a vector system, change of coordinates, Linear transformation, addition and composition; kernel and image, rank; one to one and onto maps, matrix of a linear map, Inner product, Cauchy-Schwarz, Norm, triangle inequality. Euclidean spaces, Orthogonal and orthonormal family and basis, Gram-Schmidt orthonormalization and **Fourier Series.**

2. **Matrices:** Matrix addition and multiplication, singular matrix, determinant, rank, inverse, adjoint, Linear system: abstract study, Gaussian Elimination, Transpose and conjugate matrix; similar matrix, Eigenvalues and eigenvectors of a linear map. Characteristic polynomial of a matrix, diagonalizability, Symmetric and orthogonal matrices, diagonalization of a symmetric matrix.

3. **Complex Analysis:** Complex numbers, Polar form, De Moivre's formula, complex differentiation. Cauchy- Riemann equations. Analytic functions, Elementary functions, Contour and contour integral. Cauchy's theorem and integral formula. Taylor's theorem, zeros of analytic functions. Maximum modulus principle, Laurent series, Cauchy residue theorem, poles and residue.

4. **Integral Transform:** Laplace Transform: Functions of exponential order and examples. Transforms of elementary, transcendental and special functions. Transforms of derivatives and integrals and periodic function, unit step function and impulse function. The inverse transform, Convolution theorem, solution of ordinary differential equations (IVP and BVP). Z-Transform, Fourier Transform.

Text and Reference Books

- H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley (1995).
- S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000).
- E. Kreyszig, Advanced engineering mathematics, John Wiley (1999).
- J. W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw Hill, 2008.
- D.G. Zill, P.D. Shanahan, A first course in complex analysis with applications.
- J. W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw Hill, 2008.
- JL Schiff, The Laplace transform, Springer
- G. Strang, Linear Algebra and its Applications, Fourth Edition, Books/Cole.

Course No: **PH 101**
Course Name: **Physics - I**
Credits: **4 (2-1-2)**
Course Position: **Semester 2**

Course Content:

Classical mechanics

Module 1 (Coordinate systems and Vector Calculus)

Vectors, Algebra of Vectors, Multiplying Vectors , Components of a Vector, Base Vectors, The Position Vector r and Displacement, Velocity and Acceleration, Formal Solution of Kinematical Equations, More about the Time Derivative of a Vector, Motion in Plane Polar Coordinates.

Module 2 (Newton's laws, Types of Forces and Application of Newton's laws)

Newton's Laws and Inertial Systems, Base Units and Physical Standards, Algebra of Dimensions, Applying Newton's Laws, Dynamics Using Polar Coordinates.
Fundamental Forces of Physics, Gravity, Some Phenomenological Forces, A Digression on Differential Equations, Viscosity, Hooke's Law and Simple Harmonic Motion.
Dynamics of a System of Particles, Center of Mass Coordinates, Conservation of Momentum, Impulse and a Restatement of the Momentum Relation, Momentum and the Flow of Mass, Rocket Motion.

Module 3 (Work-energy theorems, conservative forces and angular momentum)

Integrating Equations of Motion in One Dimension, Work and Energy, Conservation of Mechanical Energy, Potential Energy, What Potential Energy Tells Us about Force, Energy Diagrams, Non-conservative Forces, Conservation Laws and World Energy Usage.

Small Oscillations in a Bound System, Stability Normal Modes Collisions and Conservation Laws.

Angular Momentum of a Particle, Fixed Axis Rotation, Torque and Angular Momentum, Dynamics of Fixed Axis Rotation, Motion Involving Translation and Rotation, Work–Energy Theorem and Rotational Motion, Vector Nature of Angular Velocity and Angular Momentum, Gyroscope.

Module 4 (Central forces, gravitation, Kepler's law dynamics of rigid bodies (2D))

Central Force Motion as a One-body Problem, Universal Features of Central Force Motion, Energy Equation and Energy Diagrams, Planetary Motion, Some Concluding Comments on Planetary motion, Integrating the Orbit Integral and Properties of the Ellipse.

Module 5 (Harmonic oscillators and waves)

Simple Harmonic Motion: Review, Damped Harmonic Oscillator, Driven Harmonic Oscillator, Transient Behavior, Response in Time and Response in Frequency.
Types of waves, Energy and Power of a Wave travelling along String, Wave Equation, Standing waves and Resonance, Travelling Sound waves, Doppler Effect and Supersonic speed and Shock waves.

Text Book:

An Introduction to Mechanics by Daniel Kleppner and Robert Kolenkow, Cambridge University Press

References:

Berkely Physics Mechanics Vol. 1 by Charles Kittel, Walter D. Knight, Malvin A. Ruderman
Physics for Scientists and Engineers, Fishbane, Gasiorowicz, Thornton, Prentice Hall

LABORATORY WORK

Objectives:

The objective of the course is to let the students understand practically what basic laws and their effects are. They will practice mechanical, thermodynamical, optical and electromagnetical experiments and will be able to develop their intuitive understanding of natural effects. In parallel with the theoretical lectures they will face reality and will be in position to make links with its mathematical expressions.

Course Content:

Mechanics (Semester 1)

1- Maxwell's wheel: free fall, inertia momentum
2- Pendulum: Eigen frequency of an oscillator, momentum, gravity force
3- Collisions of projectiles: 1D motion, elastic and inelastic collisions
4- Vibrating string: standing waves, eigenmodes, influence of boundary conditions
5- Acoustic Doppler effect: analogic mixing of electric signal to detect a change in the frequency
6- Kundt's tube: to determine velocity of sound in air
7- Lee's disk method: to measure thermal conductivity of various insulators
8- Force and momentum: to validate Newton's laws of motion

Course Code: **CH 102**
Course Name: **Chemistry Laboratory**
Credits: **3 (2-0-2)**
Course Position: **Semester 2**

Objectives:

The objective of the course is to let the students understand basic organic and polymer chemistry and applied topics related to engineering and to illustrate, through experiments, the principles of chemistry taught in this and earlier semester. Apart from learning safe working practices in a chemical laboratory, students will learn to perform experiments both on measurement of physical and chemical properties as well as synthesize and characterize simple organic molecules and polymers.

Module – 1: Chemical Kinetics: Rate Law and order of reactions; extent of reaction, Determination of reaction rates; Effect of temperature; Theories of chemical kinetics; Introduction to Catalysis (air pollution, catalytic converter).

Module – 2: Organic chemistry: Structural isomers and stereoisomers, optical activity, absolute configurations and conformational analysis. Introduction to organic reactions involving substitution, addition, elimination, oxidation and reduction. Reaction mechanisms and reactive intermediates. Chromatographic techniques. Synthesis of some commonly used drug molecules.

Module – 3: Polymers: Synthetic and natural polymers. Methods of polymerization, Molecular weight and determination, Glass transition temperature. Structure-property correlations. Examples of some specific polymers.

Module – 4: Electrochemistry: Electrochemical Cell, Half-cell reactions and electrodes, Standard electrode potential, Electrochemical Series, Nernst equation. Electrochemistry of corrosion and preventive methods. Batteries: different types of batteries and applications.

Module – 5: Nanoscience: Basics of nanomaterials, Synthesis- Bottom-up and Top-down approach, Characterization- Electron microscopy techniques, Applications- electronics, medicinal.

List of laboratory experiments:

1. Determination of total hardness of water by complexometric titration.
2. Determination of surface tension of a liquid by drop count method and the effect of additives.
3. Study of kinetics of hydrolysis of ester.
4. Determination of equilibrium constant of $KI + I_2 = KI_3$ by solubility method.
5. Simultaneous determination of concentrations of strong and weak acid in a mixture using conductometric titrations.
6. Preparation of phosphate/citrate buffers and evaluating their pH resistance.

7. Estimation of amount of Cu^{2+} or Ni^{2+} present in a solution using UV-Visible spectrophotometer and Beer-Lambert's law.
8. Synthesis of silver nanoparticles by reduction of $AgNO_3$ and the evaluation of the optical properties by UV-Vis spectrophotometry.
9. Synthesis of benzillic acid from benzil using solid phase synthesis (Green chemistry).
10. Synthesis and FT-IR spectroscopic characterization of dibenzalacetone.
11. Determination of critical micellar concentration (CMC) of a surfactant.
12. Synthesis of an organometallic complex and spectroscopic characterization.
13. Synthesis of a polymer such as Bakelite.
14. Paper chromatography and separation of natural pigments.
15. Synthesis of Aspirin.

Text books:

- Atkin's Physical Chemistry; 10th edition; Peter Atkins and Julio De Paula; ISBN 978-0-19-954337-3
- Organic Chemistry; Jonathan Clayden, Nick Greeves and Stuart Warren; ISBN: 978-0-19-927029-3

Course Code: **ES 105**
Course Name: **Electronics**
Credits: **4 (2-1-2)**
Course Position: **Semester 2**

Course Content:

Module 1: Signals and signal processing: Analog, Discrete and Digital signals and their characterization; Electronic circuits for implementing mathematical operations; Need for active devices; Transistors: characteristic, load line and biasing techniques; Small signal transistor amplifiers and its incremental equivalent circuit;

Module 2: Differential amplifier: its characteristics and operation; Mathematical operations performed using Operational Amplifier (OPAMP); CMRR, slew rate and gain-bandwidth product; OPAMP based amplifiers and applications: spectral analysis and active filters;

Module 3: Feedback: various topologies of feedback network; Nonlinear applications of OPAMP, sinusoidal oscillators and negative resistance circuits;

Module 4: Power amplifiers: Class A, AB, B, C, D: their operations and efficiency; Rectifier circuits, voltage regulators and power supplies;

Module 5: Introduction to digital circuits: ADC/DAC and their implementations; Digital Logic Gates, representing boolean functions: expression, truth table, circuit; boolean minimization using Karnaugh maps; Adders; Comparators; Multiplexers; Encoders / Decoders; Latches – SR Latch, D Latch; Flip Flops – D, JK, T Flip-flops; Synthesizing sequential state machines.

Textbooks:

1. A. Malvino, D. J. Bates; Electronics Principles; Seventh Edition, McGraw-Hill, 2007.
2. R. A. Gayakwad; Op-amps and Linear Integrated Circuits; Fourth Edition, Prentice Hall, 2000.
3. M. M. Mano; Digital Logic and Computer Design; First Edition, Pearson Education, 2004.

Course Code: **ES 106**
Course Name: **Introduction to Computer Science**
Credits: **4 (2-1-2)**
Course Position: **Semester 2**

Module 1
Representation of data: Number systems; Conversion from one base to the other; Binary number system; Representation of Binary numbers using Physical devices; Basic logic gates and binary logic; Short, Int, Long types; Integer arithmetic using logic gates; Float point representation; Float, Double, long Double data types; Characters - ascii codes; Boolean variables; IEEE standards and history.

Module 2
Von Neumann architecture of modern computing system; Low level languages vs High level Languages; Compilation and byte code; Introduction to C programming language; Variables, type declaration and operations.
Control structures and manipulation of data: Conditional Constructs if, ifelse, while, for, do-while, switch, break, continue.
Functions: Implementation of functions in C, recursion, Iteration vs recursion.

Module 3
Pointers and Arrays
The pointer datatype; Declaring pointer variables; Passing a reference using pointers; Null pointers.
Arrays; Declaring and using arrays; Arrays as parameters; Strings in C;
Relation between arrays and pointers; N-dimensional arrays; What is an algorithm?;
Algorithms: Sorting examples - Insertion sort, Bubble sort, mergesort.
Searching examples - linear search, Binary search.
Structures; Dynamic Memory Allocation; Malloc - Free functions; Dynamically Sized arrays; Implementation of Linked lists.
File handling: Reading and writing files; Writing header files; Make and Installation Packages.

Module 4
Introduction to interpreted languages; Introduction to Python3; Dynamic typing; inbuilt data types - Strings, Lists, Tuples, Sets, Dictionaries, and methods. Subcriptables and Iterables; the while and for loops; Functions - Polymorphism in Python functions; Introduction to Python classes; Brief introduction to Object Oriented Programming.

Module 5
Standard modules in Python for scientific computing and plotting; Handling files; Implementation of various algorithms (search, sort etc) in Python; Speed comparison with C; Integration of C programs into Python scripts.

References

1. Introduction to Computing Systems: From Bits & Gates to C & Beyond; Yale Patt & Sanjay Patel
2. C: How to Program; Paul Deitel, Harvey Deitel
3. Dive into Python; Mark Pilgrim
4. Beginning Python: Novice to Professional; Magnus Lie Heitland
5. Python Algorithms; Magnus Lie Heitland

Course Code: **ES 107**
Course Name: **Workshop Practice**
Credits: **0 (0-0-2)**
Course Position: **Semester 2**

List of Experiments:

1. Introduction to Workshop: Overview and Safety Practices (1 week)
2. Hand Tools & Machining Demonstration (1 week)
3. Benchwork and Fitting (2 weeks)
4. Woodwork and Carpentry (2 weeks)
5. Welding Demonstration (1 week)
6. Introduction to Machine Tools (1 week)
7. Lathe and Milling: Basic Operations (2 weeks)

Textbook: Workshop Practice by B. L. Juneja, 2016, Cengage Learning.

Course Code: **SE 102**
Course Name: **Introduction to Enterprises and Economy**
Credits: **3 (2-1-0)**
Course Position: **Semester 2**

Objectives:

The course provides students with a structured understanding of how companies operate and can be managed. After the class, students should be familiar with concepts such as governance, strategy, partnering, organizing, etc.

Course Content:

- Introduction: objectives, stakeholders, operations and product life cycles
- Marketing of products and services
- Corporate strategy
- Growth process and strategic plan
- Structure and processes, informal organization
- Performance driving and operations management
- Management of innovation and technology

Text Books/ References:

Course reader in English + copy of the slides presented in class

- The structuring of organizations, H. Mintzberg
- Principles of ecomomy, N. Gregory Mankiw
- Economics, Organization and Management, Paul Milgrom and John Roberts

Course Code: **HS 102**

Course Name: **Professional Ethics**

Credits: **1 (0-1-0)**

Course Position: **Semester II**

Course Content:

Module 1: Why be moral? Introduction to ethical theories. Is and Ought. What is and what ought to be? Fact-value distinction

Module 2: End and Means. Classical dilemma, Debates and theories. Gandhian Ethics. The concept of shreyas and preyas.

Module 3: Justice. Classical theories of justice. Crime and punishment. Malpractices.

Module 3: Rights, Duties and Responsibilities. Natural rights, Fundamental rights and Human dignity. Freedom and autonomy. Duties and responsibilities. Legal rights. Patents and intellectual rights

Module 4: Good Life. Happiness. Harmony. Care and Compassion

Module 5: Case studies of professionals, institutions and organizations

Textbooks / References:

1. Handouts of classical texts by various philosophers will be provided to students. (Socrates, Kant, Hume, Locke, Mills, Bentham, Rawls, Gandhi, etc.)
2. Practical Ethics by Peter Singer
3. Applied Ethics by Peter Singer
4. What We Owe Each Other by T. M Scanlon
5. Fundamental Ethics – for Scientists and Engineers by Edmund Seebauer and Robert Barry

Course Code: **FL 102**
Course Name: **French Language and Culture - II**
Credits: **0 (0-2-0)**
Course Position: **Semester 2**

Objectives:

To develop basic LSRW skills in French Language, from learning how to pronounce and write French alphabet to picking up phrases and words in written, spoken communication through listening and reading exercises.

Contents:

A) Topics

- Family
- Hobbies and pastimes
- Leisure activities
- Describing habit and routines
- Weather description

B) Grammar

- Possessive adjective
- Near future
- Past tense
- Negation
- Spatial location : - venir de / aller à + ville ou pays
- Adverb of time: now, this week, tomorrow, last month etc…
- Fixed preposition with some verbs(aller, venir, faire, jouer)

C) Types of writing

- Post card writing
- Family tree
- Likes and dislikes with advanced notions

Course Code: **MA 203**
Course Name: **Mathematics - III**
Credits: **4 (3-1-0)**
Course Position: **Semester 3**

Course Content:

1. Probability and Random Variables
Axiomatic definition of probability, Sample Space, Events, Conditional Probability, Independence of Events, Theorem of Total Probability, Baye's Theorem, Discrete and Continuous Random Variables, Probability Mass Function, Probability Density Function, Cumulative Distribution Function, Moments, Mathematical Expectation, Variance, Standard Deviation, Moment Generating Function.

2. Discrete and Continuous Distributions
Binomial Distribution, Poisson Distribution, Uniform Distribution, Exponential Distribution, Normal (Gaussian) Distribution, Markov's Inequality, Chebyshev's Inequality.

3. Random Vectors
Joint Probability Distribution of Functions of Random Variables, Independence of Random Variables, Covariance, Variance, Expectation, Correlation, Multinomial Distribution, Transformations of Random Variables, The Law of Large Numbers, The Central Limit Theorem.

4. Random Processes
Continuous and Discrete Random Processes, Autocorrelation Function, Auto covariance Function, Correlation Coefficient, The Bernoulli Process, The Poisson Process, The Wiener Process, The Markov Chain, Stationarity: Strict-Sense Stationary (SSS) and Wide-Sense Stationary (WSS) Processes.

5. Statistics
Descriptive Statistics: Sample Mean, Sample Variance, Sample Standard Deviation and Sample Correlation Coefficient; Confidence Intervals, Parameter Estimation: Unbiasedness, Consistency, Point Estimator, Maximum Likelihood Estimators.

Text Book:
Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier, Fifth Edition 2016.

Reference Books

- Sheldon M. Ross, Introduction to Probability Models: 11th Edition, Academic Press Elsevier, 2015.
- Jean Jacod and Philip Protter, Probability Essentials, Springer, 2004.
- Hogg, Tanis and Rao, Probability and Statistical Inference: 7th Edition, Pearson, 2006.
- Alberto Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, Pearson, 2008.

Course Code: **PH 202**
Course Name: **Physics II**
Credits: **5 (3-1-2)**
Course Position: **Semester 3**

Course Contents

Electrostatics

Physical definitions of Gradient, divergence and curl operators, curvilinear coordinates,
Dirac Delta function, Theory of vector fields, Coulomb's law and principle of superposition,
Gauss's law and its applications, Electric potential and electrostatic energy, Poisson's and
Laplace's equations with simple examples, uniqueness theorem, boundary value problems,
Properties of conductors, Multipole expansion, Electric fields in matter, Dielectrics and
polarization

Magnetostatics

Biot & Savart's law, Amperes law, Divergence and curl of magnetic field, Vector potential,
Vector potential, Magnetic field in matter, Bound currents, Field H, Classification of magnetic materials, Faraday's law in integral and differential forms, Motional EMF, Displacement current

Electromagnetism

Maxwell's equations, Electromagnetic waves, wave equation, e.m. waves in vacuum and
media, refractive index, Energy and momentum of e.m.w., Poynting vector, Polarization of
e.m. waves, Reflection and refraction, skin depth, standing electromagnetic waves, Electric
dipole radiation, Waveguides with rectangular metallic boundaries, TE, TM and TEM mode.

Optics

Some discussions on geometrical optics, Wave optics: Interference between two coherent
waves, Fresnel and Fraunhoffer diffraction, Diffraction grating, polarization, Fiber Optics

Labs

- Geometrical optics with lenses
- Newton's rings
- Single-and double-slit diffraction
- Spectrometry of a glass prism
- Polarization study with half and quarter wave plates
- Helmholtz coils
- Faraday's law
- B-H loop
- Hall effect

Course Code: **ES 208**

Course Name: **Mechanics**

Credits: **3 (2-1-0)**

Course Position: **Semester III**

Course Contents:

Module 1: Introduction to Mechanics
Fundamental concepts and definitions – Systems of units – Force vectors – Equilibrium of a particle – Resultants of force systems – Moment of a force – Moment of a couple – Simplification of force and couple systems – Reduction of simple distributed loading.

Module 2: Analysis of Structures
Equilibrium of a rigid body – Conditions for rigid-body equilibrium – Free-body diagrams – Equilibrium in two dimensions – Equations of equilibrium – Simple trusses – The method of joints – The method of sections – Analysis of frames – Analysis of cables – Cables subjected to concentrated loads – Cables subjected to distributed loads.

Module 3: Friction, Center of Gravity and Moment of Inertia
Characteristics of dry friction – Problems involving dry friction – Wedges – Frictional forces on screws and flat belts – Rolling resistance – Center of gravity, center of mass and centroid – Composite bodies – Theorems of Pappus and Guldinus – Resultant of general distributed loading – Definition of moments of inertia for areas – Parallel-axis theorem for an area – Radius of gyration of an area – Moments of inertia for composite areas.

Module 4: Virtual Work
Definition of work – Principle of virtual work – Principle of virtual work for a system of connected rigid bodies – Conservative forces – Potential energy – Potential energy criterion for equilibrium.

Module 5: Selected Topics in Engineering Dynamics
Brief review of kinematics and kinetics of particles: Rectilinear kinematics, Curvilinear motion, Motion of a projectile – Newton's laws of motion – Central-force motion and space mechanics – Principle of work and energy – Conservation of energy – Principle of impulse and momentum – Conservation of linear momentum for a system of particles – Angular momentum – Planar rigid-body motion – Translation – Rotation about a fixed axis – Instantaneous centre of rotation.

Textbook/References:
1. F. Beer, E. Johnston, D. Mazurek, P. Cornwell, B. Self, S. Sanghi: Vector Mechanics for Engineers: Statics and Dynamics, McGraw Hill India, 2017.
2. R.C. Hibbeler, Engineering Mechanics: Statics and Dynamics, 11th edition, Pearson, 2009.
3. A.P. Boresi, R.J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1st edition, Cengage Learning, 2008.

Course Code: **ES 209**
Course Name: **Signals and Systems**
Credits: **4 (3-1-0)**
Course Position: **Semester 3**

Course Content:

Module 1: Characterization and classes of signals; Representation of signals: orthonormal expansion; Analytic signal; Hilbert Transform; Transforms on signals: Fourier Transform; Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT);

Module 2: Analytic signals, Hilbert Transform, Real part sufficiency; Laplace transform; Random signals: Characterization and representation of discrete and continuous random processes, Orthogonal expansion and Kahrunen Loeve series; Discrete signals: Sampling, sampling function and error in sampling; Z-transform, Properties of z-transform, inverse z transform;

Module 3: Discrete LTI systems: Linear Difference Equations and z-transform; State variable representation of discrete systems; Continuous LTI systems - impulse response, Transfer Function, pole zero concepts; state variable representation of continuous systems; Eigen value and Eigen functions of LTI systems, their significance;

Module 4: Stability, controllability, Observability and their significance, state estimation and state control; Feedback: stability, RH criterion, root locus, Nyquist criterion; Output feedback Control: P.PI.PD.PID;

Module 5: Transmission of random processes through LTI systems; Generation of WSS signals, spectral factorization; Estimation of random signals in noise; Linear Time Varying Systems: Time varying impulse response; Digital Filters: FIR and IIR filters, and their synthesis.

Textbooks:

1. Oppenheim, Wilsky, Nawab; “Signals and Systems”; Second Edition, PHI.
2. J. G. Proakis and Manolakis; “Digital Signal Processing”; Fourth Edition, PHI.
3. K. Ogata; “Modern Control Systems”; Fifth Edition, PHI.

Course Code: **ES 210**
Course Name: **Data Structures**
Credits: **5 (2-2-2)**
Course Position: **Semester 3**

Module 1

Introduction to Data Structures: Single and Multi-dimensional Arrays, Sparse Matrices (Array and Linked Representation)
Introduction to Algorithms: Algorithm Development, Complexity analysis, Recursion. Growth of Functions & Asymptotic Notations. Rates of Growth: O(n), Ω(n), Θ(n), o(n), ω(n), Run-Time Complexity, Space Complexity, NP-Completeness (Time Permitting). Complexity Class - P, NP, NP Complete, NP Hard, Is P=NP? and Reductions.

Module 2
Linear Data Structures- Stacks: Operations and Applications, Implementing single / multiple stack/s in an Array; Prefix, Infix and Postfix expressions, Applications of stack; Limitations of Array representation of stack.
Links Lists: Operation – Creations, insertion, Deletion, Circular Lists, Doubly Linked List. (Approaches, Implementation Issues, Complexity & Efficiency), Amortized Analysis.

Module 3
Array and Linked representation of Queue, De-queue, Priority Queues, Circular Queues: Operations and Applications
Sorting Algorithms & Searching: Bubble sort, Quick Sort, Insertion Sort, Merge Sort, Selection sort, Heap Sort, Radix sort and Bucket sort. Lower bound for comparison based sorting algorithms. Linear Search, Binary Search.

Module 4
Introduction to Hashing, Deleting from Hash Table, Efficiency of Rehash Methods, Hash Table Reordering, Resolving collusion by Open Addressing, Coalesced Hashing, Separate Chaining, Dynamic and Extendible Hashing, Choosing a Hash Function, Perfect Hashing Function
Introduction to Tree as a data structure; Binary Trees (Insertion, Deletion , Recursive and Iterative Traversals on Binary Search Trees); Threaded Binary Trees (Insertion, Deletion, Traversals); Height-Balanced Trees (Various operations on AVL Trees).

Module 5
Graphs I: Representation and Traversal (Preorder, Inorder, Postorder)

- Representation: Matrix, Adjacency list
- Traversal: Depth First Search, Breadth First Search

Graphs II: Basic Algorithms

- Minimum Spanning Tree
- Shortest Path
- All pairs Shortest Path, Transitive Closure

Reference Books

R1. Aaron M. Tenenbaum, Moshe J. Augenstein, YedidyahLangsam, "Data Structures Using C
and C++:, Second edition, PHI, 2009.
R2. Micheal T. Goodrich and Roberto Tamassia: Algorithm Design: Foundations, Analysis and Internet examples (John Wiley &Sons, Inc., 2002)
R3. Cormen T.H., Leiserson, C.E., Rivest, R.L., and C. Stein. Introduction to Algorithms, MIT Press, Second Edition (Indian reprint: Prentice-Hall).
R4. Sanjoy Das Gupta, Christos Papadimitriou, Umesh Vazirani, AlgorithmsTata McGraw-Hill Publishers
R5. Alfred V. Aho, John E. Hopcroft, Jeffery D.Ulman. Data Structures and Algorithms
R6. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran. Computer Algorithms
R7. Robert L. Kruse, "Data Structures and Program Design in C++", Pearson,1999.

Course Code: **ME 201**
Course Name: **Computer Aided Engineering Design**
Credits: **3 (1-0-4)**
Course Position: **Semester 3**

Module 1:

Introduction and overview - Need and Scope of Computer Aided Drafting for Design-Role of Geometric Modelling (line, surface and solid modelling)

Module 2:

Introduction to computer aided part modeling techniques. Conversions of 2D profiles into 3D models-using extrude/protrude and revolve commands. Cutouts/shell creation, placing holes, rounds/fillets, chamfers, creating rectangular and circular array/patterns, array/patterns along a path/curve, mirroring features, editing of a model, creating internal and external threads. Using part modeling techniques create the following Machine Parts with Front View, Top View and Side/Profile view/auxiliary view/section view: Hexagonal Nut and Bolt, Solid Muff Coupling, Bushed Journal Bearing, Foot Step Bearing, Knuckle Joint, Socket and Spigot joint.

Module 3:

Introduction to computer aided assembly modeling techniques. Types of assembly design approach: bottom-up and top-down assembly. Creating assembly and sub-assemblies. Editing and modifying assembly relationships. Creating exploded view of the assembly, Inserting Bill of Materials, Adding Balloons. Understand Detail drawing, Know the procedure for detail drawing, Creation of Production drawing, Introduction to limits, fits and tolerances, dimensional and geometric tolerances, surface finish symbols. Practical examples using industrial drawings.

Module 4:

Computer aided drafting practice - Plummer block (Pedestal Bearing), I.C. Engine connecting rod, Screw jack (Bottle type), Tailstock of lathe, Machine vice, Lathe square tool post, Pipe vice, Rams Bottom Safety Valve.

Module 5:

Basics of parametric modeling - Geometric constraints to create relationships - Use parameters to create advanced geometric relationships

Textbook/tutorial:

1. Prof. Sham Tickoo, Autodesk Inventor Professional 2018 for Designers, CADCIM Technologies, 18 edition, 2017

2. David Rogers and J. Alan Adams, Mathematical elements for computer graphics, McGraw Hill Education, 2017.

Reference Books:

1. Saxena Anupam, and Sahay Birendra, Computer Aided Engineering Design, Springer, 2005.
2. Mortenson M. E., Geometric Modeling, John Wiley and Sons, 1985.
3. Warren Hammer, Blue Print Reading Basics, 3rd Edition, Industrial Press Inc.
4. Luzadder, Fundamentals of Engineering Drawing: With An Introduction to Interactive Computer Graphics for Design and Production, Prentice Hall of India Pvt. Ltd., 11th Edition, 1994.

Narayana K L, Machine Drawing, 5th Edition, New Age International Pvt Ltd, 2016.

Course Code: **FL 203**
Course Name: **French Language and Culture - III**
Credits: **0 (0-2-0)**
Course Position: **Semester 3**

Objectives:

The aim of this course is to understand very short, simple information in the spoken and written language and to express oneself simply and briefly in speech and in writing for practical purposes in everyday situations requiring a direct exchange of information. It is expected that productive skills will be limited and fragmented and that language will be mostly or completely formulaic at this level; receptive skills will be more developed than productive skills.

Course Content:

General themes

- People: Family, Physical description
- Places: Cafe, Restaurant, Shops, Bank, Post office, Hotel, Road
- Hobbies: Sports, Going out, Shows, Holiday trips
- Daily Life: Work, Shopping,
- Daily activities

Grammar topics

- Pronominal verbs: verbes reflechis and pronominal verbs
  Past Simple - events in the past
- Past participles
  Imperfect tense - descriptions in the past (it was, there was)
  Imperative - Affirmative and Negative - for instructions and commands
- Near Future Tense
  Future simple tense
- Conditional tense

Course Code: **ES 211**
Course Name: **Numerical Methods**
Credits: **4 (3-0-2)**
Course Position: **Semester 4**

Course Content:

1. **Algebraic and Transcendental equations:** Computation of floating point numbers and round-off errors and machine representation of numbers. Solutions of non-linear and transcendental equations: order and convergence analysis.

2. **Interpolation, numerical differentiation and Integration:** interpolation; Numerical differentiation, Richardson's extrapolation; Numerical integration: Newton-Cotes formulae, Romberg integration, quadrature formulae.

3. **System of Algebraic Equations:** Norms of vectors and matrices, Linear systems: direct and iterative schemes, ill conditioning, convergence analysis and finding dominant eigenvalues; Numerical schemes for nonlinear systems (Newton's method); Regression.

4. **Ordinary differential equations:** Difference equations; Numerical solution of differential equations: Single step and multi-step methods, order consistency, stability and convergence analysis, stiff equations; Solving two-point boundary value problems by shooting methods and finite difference methods.

Text book:

1. David Kincaid and Ward Cheney, Numerical Analysis and mathematics of scientific computing, Books/Cole, 1999.

References:

- Samuel D. Conte and Boor, Elementary Numerical Analysis: Algorithmic Approach, Tata McGraw-Hill, 1980.
- K. Atkinson, Elementary Numerical Analysis, John Wiley, 1978.
- Richard L Burden and J Douglas Faires, Numerical Analysis, Thomson Books Cole, Seventh edition 2009.

Course Code: **ME 202**
Course Name: **Transport Phenomena**
Credits: **4 (3-1-0)**
Course Position: **Semester 4**

Course Content:

INTRODUCTION TO FM (Fluid Properties, Velocity & Stress Fields, System and Control Volume, No Slip Condition, Flow Types)

HYDROSTATICS (Basic equation of fluid statics, Absolute and Gauge pressures, Manometry, Forces on Submerged Bodies, Buoyancy and Stability)

FLOW KINEMATICS (Lagrangian and Eulerian Descriptions, Acceleration Fields, Material Derivative, Types of Motion and Deformation, Flow patterns, Reynolds Transport Theorem)

FLUID DYNAMICS (*Integral Analysis:* - Continuity, Momentum and Energy equation; Applications of Linear Momentum Equation: Forces on pipe junction, bends; Applications of Energy Equation: Bernoulli's equation, Venturimeter, Orifice, Pitot Tubes. *Differential Analysis:* - Continuity, Momentum and Energy equation, Navier Stokes Equation, Euler's Equation, Vorticity, Stream Function.)

DIFFUSION MASS TRANSFER (Physical Origins and Rate Equations, Conservation of Species, Mass transfer in Stationary and Non-Stationary Medium, Boundary Conditions and Discontinuous Concentrations)

CONDUCTION HEAT TRANSFER (Rate Equation, Properties, Diffusion Equation; Plane Wall, Radial Systems, Conduction w/ Energy generation, Lumped Capacitance)

CONVECTION HEAT TRANSFER (Convection Boundary Layers, Convection Coefficients, Laminar and Turbulent BLs, BL Equations, Physical Significance of Dimensionless Parameters)

RADIATION HEAT TRANSFER (Fundamental Concepts, Radiation Intensity, Blackbody and Graybody Radiation, Radiation Properties)

Text Books:

Primary Ref:

"Fluid Mechanics", Fox et. al., 8^{th} Ed, Wiley

"Fundamentals of Heat and Mass transfer", Incropera, DeWitt et. al., 6^{th} Ed, Wiley

Additional Ref:

“Fluid Mechanics”, Cengel et. al.,
“Fluid Mechanics”, Som et. al.,
“Heat Transfer”, Cengel
“Heat Transfer”, Holman et. al.

Course Code: **ME 203**
Course Name: **Manufacturing Processes - I**
Credits: **3 (3-0-0)**
Course Position: **Semester 4**

Module 1: Metal Forming
Elastic and plastic deformation. Concept of strain hardening. Hot and cold working processes -rolling, forging, extrusion, swaging, wire and tube drawing. Machines and equipment for the processes. Parameters and force calculations. Test methods for formability.

Module 2: Sheet Metal Working
Applications of sheet formed products. Shearing mechanism. Processes like blanking, piercing, punching, trimming, etc. Forming processes like bending, cup drawing, coining, embossing, etc. Presses for sheet
metal working; Part feeding systems; Elements of die; punch and die clearances; Progressive, compound
and combination dies.

Module 3: Powder Metallurgy
Introduction. Production of metal powders. Compaction and sintering processes. Secondary and finishing operations. Economics, advantages, and applications of powder metallurgy.

Module 4: Metal Casting
Introduction, patterns, molding, cores, gating system, risers, defects, Special Molding Processes.

Module 5: Welding and Additive Manufacturing
Introduction: Principle of welding, Classification of welding processes, Soldering and brazing, Unconventional welding Process.

Introduction to Micro Manufacturing and Additive manufacturing.

Text book: Manufacturing Engineering and Technology by Groover; TMH Publication.

Reference books:

1. Manufacturing Technology by P. N. Rao; McGraw Hill Education (India) Pvt Ltd
2. Manufacturing Science by Amitabha Ghosh, Ashok Kumar Mallik

Course No: **ME 204**
Course Name: **Mechanics of solids**
Credits: **3 (2-1-0)**
Course Position: **Semester 4**

Course Content:

Module 1:

Stress-Strain behaviour for uniaxial loading, Generalized Hooke's law, Elastic constants for isotropic materials, Notion of equilibrium, Free body diagrams, Deformation of axial members, Statically determinate and indeterminate problems, Truss structures – Stiffness methods.

Module 2:

Definition of stress, Different states of stress – uniaxial, biaxial, plane stress, Transformation of plane stress, Principal stresses and maximum shear stress, Mohr's circle.
Definition of strain – shear and normal strains, Transformation of plane strain, Principal strains

Module 3:

Bending of beams: Relation between transverse loads, shear and bending moments, Shear and bending moment diagrams, Shear stresses in beams, Deflections in beams.

Module 4:

Torsion: Torsional moment diagrams, Torsion formula for circular cross-sections, Maximum normal and shear stresses, Angle of twist, Power transmission through shafts.

Module 5:

Elastic stability: Notion of stability of equilibrium, Euler buckling.

Textbooks / Reference books:

An Introduction to the Mechanics of Solids, Crandall S.H, Dahl N.C, McGraw-Hill.

Course Code: **ME 205**
Course Name: **Theory of Mechanisms and Machines**
Credits: **4 (2-1-2)**
Course Position: **Semester 4**

Module 1: Basics of Mechanisms
Definitions of Machine, Mechanism, Links, and Pairs; Classification of Mechanisms; Mobility – Kutzbach Equation and Grübler's Criterion; Kinematic Inversion; Range of Motion – Grashof's Law

Module 2: Kinematic Analysis of Mechanisms
Position and Displacement, Velocity, Acceleration using Graphical and Analytical Methods; Coupler Curve Generation; Instantaneous Centres of Velocity and Acceleration; Aronhold – Kennedy Theorem of Three Centres, First and Second Order Kinematic Coefficients

Module 3: Kinematic Synthesis
Type, Number, and Dimensional Synthesis; Freudenstein's Equation; Function Generation, Path Generation, and Body Guidance; Coupler Curve Synthesis

Module 4: Cams, Gears, and Mechanism Trains
Classification of Cams and Followers, Displacement Diagrams, Standard Cam Motions; Radial Cam with Translating Flat-face Follower, Radial Cam with Translating Roller Follower
Fundamental Law of Toothed Gearing, Spur Gears, Helical Gears, Bevel Gears, Worm and Worm Gears; Parallel-Axis Gear Trains, Epicyclic Gear Trains, Differentials

Modules 5: Dynamics of Machinery
Introduction to Static and Dynamic Force Analyses using Slider-Crank Mechanisms; Dynamics of Reciprocating Engines; Flywheels, Governors, and Gyroscopes; Static and Dynamic Balancing

Laboratory:
1. Graphical Analysis of Displacement, Velocity and Acceleration
2. Graphical Linkage Synthesis
3. Demonstration of Gears, Differentials, and Cams using Automobiles
4. Computational Kinematics Project (optional)

Textbooks:
1. Theory of Machines and Mechanisms by John J. Uicker Jr., Gordon R. Pennock, and Joseph E. Shigley, Fourth Edition (International Version), Oxford University Press, 2015.
2. Theory of Mechanisms and Machines by Amitabha Ghosh, and Ashok K. Mallik, Third Edition, East West Press Private Limited, 1998.

Reference Books:
1. Kinematics and Dynamics of Machinery by Robert L. Norton, First SI Edition,

McGraw Hill Higher Education, 2008.
2. Theory of Machines by S. S. Rattan, Fourth Edition, McGraw Hill Higher Education, 2014.
3. Mechanism Design: Analysis and Synthesis, Volume I by Arthur G. Erdman, George N. Sandor, and Sridhar Kota, Fourth Edition, Prentice Hall Inc., 2001.

Course code: **SE 203**
Course Name: **Design Thinking**
Credits: **2 (1-0-2)**
Course Position: **Semester 4**

1st week:

Exercise 1**:** Drawing practice using subconscious mind with the help of music…. Al Di Meola (Race with Devil on Spanish Highway), Beethoven Symphony No.9, Hans Zimmer - Kings of the Past, Pink Floyd - Terminal Frost etc. Another exercise was to create a story from subconscious mind.

Exercise 2: 2D drawing from conscious mind and create a story.

Exercise 3: 2D Story making following story board & comic strips type.

2nd week:

Introduction 3D, where 'D' stands for dimension, which means an object has three dimensions. X-axis, Y-axis and extra dimension are the Z-axis which gives height/width/depth to an object.

Exercise 1**:** Composition exercise 3D, Create a new 3d compound structure using any one symmetrical and asymmetrical pattern with the help of colour paper

3rd week:

3d exploratory prototyping/ connection of variety objects….Bangles, Rubber band, Scooby sticks, Marbles, Paper cups. This is a brain storming activity. Where they will learn how to build a product with the help of very limited object and also they need to calculate the mathematical way to function this game.

4th week:

2D form exploration Tangram

5th & 6th weeks:

Screening short films.

Exercise 1: First write down the basic theme.

Exercise 2: To identify and write down the visual and audio components of this design/narrative and also to state alongside as to what could be its motivation.

7th week:

Context-Concept- We are providing some objects (Syringe, Nail Cutter, and Stapler). Brain storms the following using object which is given them. Note the idea, possibilities and connection as possible.

1. In what contexts do you see a use for this product?
2. How did this product evolve? What are the alternatives before the product for the same need? What the problem did this product solve?
3. Think of 5 important "WHAT IF CONTEXTS" for this product?
4. Describe a PERSONA of the product.
5. Sketch your 10 new concepts based on this product.
6. What can be made it simpler, pleasurable and more meaningful?

(8th week)

Typography & Photo montage (collage) – History of typography/ Calligraphy and Photomontage. Typography plays a *critical* role in strengthening the brand, creating interest to the product, and highlighting a central message. The core purpose of a design is communication. Whether we're talking about an online ecommerce store or a corporate brochure, typography is a vital component. Typography is the art and technique of selecting and arranging type styles/fonts for texts.

Exercise 1: To write their name in two different styles (Serif and Calligraphy).

Exercise 2: Making a collage art using magazine and newspaper.

9th week

Book Cover Design: History and evolution of book. History of book covers designing.

Exercise 1: Create a book cover by using typography or any kind of creative image which can describe the book visually.

10th week

Ideating objects & Mechanical transformation-

Problem review

1. Identify the object.
2. User profile of the product.
3. Function of the product.
4. How many parts is the product made of?
5. How is each part manufactured?
6. What manufacturing processes are applied?
7. What are the alternatives uses the product?
8. What are the irritants present in this product?
9. If the product had to be redesigned, what would be your approach? Sketch the design.

11th t to 15th weeks

'Final Project and Prototype.

Course Code: **FL 204**
Course Name: **French Language and Culture - IV**
Credits: **0 (0-2-0)**
Course Position: **Semester 4**

Objectives:

The aim of this course is to understand very short, simple information in the spoken and written language and to express oneself simply and briefly in speech and in writing for practical purposes in everyday situations requiring a direct exchange of information. It is expected that productive skills will be limited and fragmented and that language will be mostly or completely formulaic at this level; receptive skills will be more developed than productive skills.

Course Content:

General themes

- Accommodation: Units in the house, interior decor
- Everyday objects
- Countries & Cities
- Actions in daily life
- Events: Meetings, Evening out, Family events, Visits, Excursions, Accidents, TV news
- Money and payments

Grammar topics

- Transitive and Intransitive verbs - Direct and Indirect object
- Relative pronoun 'there' - place
- Relative pronouns - who, that/which
- Prepositions of place: go to, be at, come from + a place
- Connectors: but, because

Course Code: **MA 304**
Course Name: **Mathematics - IV**
Credits: **4 (3-1-0)**
Course Position: **Semester 5**

Course Content:

1. Series solutions of ordinary differential equations and Special functions.

2. Partial Differential Equations: Formation and solutions of partial differential equations. Method of separation of variables, Solution of wave equation, Heat equation, Laplace's equation. Fourier transform method for solving PDEs.

3. Finite Difference methods for second order linear PDEs.

4. Variational principles and introduction to Finite Element method Galerkin method.

Text and Reference Books

- LC Evans, Partial differential equations.
- W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005).
- Ronald N. Bracewell, The Fourier Transform and its Applications, Mc-Graw Hill, 1965
- T. Amaranath, An Elementary Course in Partial Differential Equations, Jones & Bartlett Publishers.
- L. Elsgolts, Differential equations and Calculus of variations.
- G. D. Smith, Numerical solution of partial differential equations: Finite Difference methods, Oxford University press.
- Cook, Robert D; Malkus, David S; Plesha, Michael E; Witt, Robert J. Concepts and Applications of Finite Element Analysis, Wiley, 2001.
- K. Shankara Rao, Introduction to Partial Differential Equations, PHI Learning Private Limited.
- J. N. Reddy, An Introduction to Finite Element Method.
- J. N. Reddy, Applied Functional Analysis and Variational Methods in Engineering
- E. Kreyszig, Introductory functional analysis with applications, Wiley, New-York.

Course code: **ES 312**
Course Name: **Introduction to Materials Sciences**
Credits: **3 (2-0-2)**
Course Position: **Semester 5**

Course Content

Classification of Materials: Crystal and atomic structure/property correlation. Criteria for selection of materials for engineering applications. Structure-Property-Performance correlations. Lennard- Jones potential and understanding intrinsic behavior of materials.

Short-range/long-range order, Amorphous Materials, Glasses. Basic Crystallography, Bravais lattices, packing fraction, crystal structures of metallic elements. Crystal directions and planes, Miller indices, inter-planar spacings. Crystal structure determination, Polymorphism or Allotropy.

Imperfections in crystals and their importance. Types of imperfections: point, line, surface, volume. Deformation by slip, Mechanism of slip, Slip systems. Dislocations and Stacking faults. Applications of diffusion, Mechanisms of Diffusion, Fick's first law, Factors affecting Diffusion, Fick's second Law. Diffusion and Materials Processing-Case studies: Applications

Alloy formation and Hume-Rothery rules. Gibb's free energy for thermodynamic stability of phases and Gibb's phase rule. Cooling curves and Equilibrium diagrams: Unary/Binary Phase diagram, Lever rule; Invariant reactions: Eutectic, Eutectoid, Peritectic and, Peritectoid; Non-equilibrium cooling, Avrami kinetics, Phase transformation, Time-Temperature-Transformation and Continuous Cooling Transformation Diagrams. Analysis of specific alloy systems.

Steel: Fundamentals and applications. Mechanical Behaviour of Ferrous/Non-ferrous alloys: Fatigue, Creep and Failure.

Functional/ Adaptive materials: Smart Metals/Engineered alloys, sensors and actuators, Ceramic Materials, properties, processing and applications. Dielectrics, Ferroelectrics, Piezoelectrics, Multiferroics, Semiconductors and advanced functional materials.

Composite materials: Types of composites, Properties and applications.

Text:

Callister's Materials Science and Engineering, (2ed) R. Balasubramaniam, Wiley, ISBN: 9788126541607

Reference:

Materials Engineering: Bonding, Structure, and Structure-Property Relationships (1st Ed) by Susan Trolier-McKinstry, Robert E. Newnham; Cambridge University Press, ISBN-13: 978-1107103788ISBN-10: 1107103789.

Introduction To Solids by Leonid Azaroff (2017) McGraw Hill Education, ISBN-10: 0070992193ISBN-13: 978-0070992191

Course Code: **ME 306**
Course Name: **Manufacturing Processes - II**
Credits: **4 (2-1-2)**
Course Position: **Semester 5**

Module 1: Theory of Metal Cutting
Mechanics of metal cutting, Orthogonal and oblique cutting, Force relationship, merchant diagram. Turning and related operation, Drilling and related operation, Milling. Machining parameters, Heat generation, Wear, Tool Life.

Module 2: Economics of Machining
Cost per unit, Minimum cost Criteria, Maximum production rate or minimum time criteria.

Module 3: Grinding and Gear manufacturing.
Grinding, Grinding wheel specification, Gear Manufacturing, Cutting tool materials, Cutting fluids.

Module 4: Unconventional machining
Ultrasonic machining, Abrasive jet machining, Electric discharge machining, Electrochemical machining, Laser beam machining, Electron beam machining, Plasma arc machining.

Module 5: Metrology and Nondestructive testing
Selective Assembly, Fundamental deviation, Tolerances, Fits, Limit Gauges, Slip Gauges, Errors, Interferometry, Comparators, Straightness measurements, Surface finish, Screw thread metrology, Acceptance tests on lathe, drilling and milling machines.

Module 6: Computer Integrated Manufacturing
Basic concepts of CAD/CAM and their integration tools.

List of Experiments:
1. Turning operation on NC Lathe Machine.
2. Milling Operation on NC Milling Machine.
3. Surface roughness measurement experiment on finished product.
4. Gear profile Measurement.
5. Measurement of angle using Sine Center / Sine bar / bevel protractor.
6. Calibration of Micrometer using slip gauges.
7. Measurement of thread parameters on a screw.
8. Measurement of straightness and flatness.
9. Fabrication of plastic components using Semi-Automatic Injection Moulding Machine.
10. Calibration of Micrometer using slip gauges.

Text book:
1. Fundamental of Metal cutting and Machine tools by B. L. Juneja
2. Manufacturing Engineering and Technology by Groover; TMH Pub.

Reference books:

3. Manufacturing Technology by P. N. Rao; McGraw Hill Education (India) Pvt Ltd
4. Manufacturing Science by Amitabha Ghosh, Ashok Kumar Mallik

Course Code: **ME 307**
Course Name: **Applied Fluid Dynamics and Heat Transfer**
Credits: **4 (3-1-0)**
Course Position: **Semester 5**

Course Content:

DIMENSIONAL ANALYSIS (Non-dimensionalizing differential equations, Buckingham Pi Theorem, Dimensionless Parameters, Similitude and Model Studies)
INVISCID FLOWS (Bernoulli's equation - assumptions and applications, potential function, Elementary plane flows - uniform flow, source, sink and doublet)

INTERNAL INCOMPRESSIBLE VISCOUS FLOW (Boundary Layer Concepts - Entrance Region, Pipe flow; Laminar vs Turbulent - Reynolds experiment, Fully Developed Laminar Flow - Couette flow, Poiseuille flow; Empirical Relations – Laminar and Turbulent flow; Losses in Pipes – Friction Factor, Head loss)

EXTERNAL INCOMPRESSIBLE VISCOUS FLOWS (Boundary Layer Concepts: Flat Plate, Boundary Layer Thickness, Separation; Shear and Pressure Forces, Drag, Lift)

APPLIED HEAT TRANSFER (Heat Transfer from Extended Surfaces); (View factor, Opaque, Diffused, Gray Surfaces); (Flow over Flat Plate, Cylinder, Tubes and Banks, Impinging Jets; Flow inside Circular, Non-circular tubes and Annulus, Convection Correlations)

HEAT EXCHANGERS (Types, Overall Heat Transfer Coefficient, Analysis: LMTD, Effectiveness-NTU, Design and performance Calculations)

Text Books:
Primary Ref:

"Fluid Mechanics", Fox et. al., 8^{th} Ed, Wiley
"Fundamentals of Heat and Mass transfer", Incropera, DeWitt et. al., 6^{th} Ed, Wiley

Additional Ref:

"Fluid Mechanics", Cengel et. al.,
"Fluid Mechanics", Som et. al.,
"Heat Transfer", Cengel
"Heat Transfer", Holman et. al.

Course Code: **ME 308**
Course Name: **Design of Machine Elements**
Credits: **4 (3-1-0)**
Course Position: **Semester 5**

Course Content:

Introduction to the design of machine elements: Review of models of solid mechanics, uncertainties in design equations and factor of safety. The role of machine elements which are available off-the-shelf. Role of standards in machine element design.

Working Stresses and Static Failure Theories: Application of commonly used static failure theories to design: the normal stress theory, the maximum shear stress theory, and the maximum distortion energy theory. Stress concentration caused by a sudden change in form, and stress concentration factors.

Working Stresses and Dynamic Failure Theories, i.e., design for cyclic loading: Stress concentration factors for cyclic loading. Reversed stresses, fatigue, and the endurance limit. The rotating beam type fatigue test. Factors affecting fatigue strength. Surface initiated crack development. Design for fatigue stress. High cycle fatigue: The S-N curve and its statistical nature. Design for infinite life under cyclic loading: Soderberg theory, Goodman theory, and the modified Goodman theory. Design for finite life under cyclic loading: Basquin theory, combined loading and the equivalent completely reversed stress, Miner's rule for cumulative fatigue damage.

Design procedure and application to statically loaded machine elements- Design of elements subjected to simple loading: riveted joints, screws including power screws, bolted joints including eccentrically loaded joints, couplings, clutches and brakes.

Design procedure and applications to dynamically loaded machine elements: shafts, springs, bolts, gears (with a detailed study of nomenclature, kinematics, and dynamics, especially spur gearing), lubrication, journal and rolling contact bearings, belts and chains.

Text book:

Spotts, M. F., Shoup, T. E., & Hornberger, L. E., Design of Machine Elements, 8th ed., Pearson Education Inc, 2004, published in India by Dorling Kindersley (I) Pvt Ltd., ISBN: 0130489892

Reference books:
- Budynas, R. G., & Nisbett, J. K.. Shigley's Mechanical Engineering Design: McGraw-Hill.
- Norton, R. L., Machine Design: an Integrated Approach: Prentice Hall

Course Code: **ME 309**
Course Name: **Experimental analysis**
Credits: **2 (0-0-4)**
Course Position: **Semester 5**

Course Content: Students will be allotted experiments from the following set of experiments:

Venturi, Orificemeter, and rotameter apparatus

Bernoulli's Theorem apparatus

Pitot Static Tube apparatus

Flow over Notches apparatus

Orifice & Mouthpiece Apparatus

Measurement of major and minor losses in pipe flow

Reynold's Apparatus

Pelton Turbine test rig

Centrifugal Pump test rig

Tensile and compression testing of metallic materials

Verification of Euler Bernoulli theory of Beam bending

Measurement of thermal conductivity of a metal rod

Natural convection apparatus

Forced convection apparatus

Estimation of Stephen Boltzmann constant

Heat transfer from a Pin Fin

Universal vibration apparatus to study vibrations

Static and Dynamic Balancing apparatus

Motorized Gyroscope

Universal governor apparatus

Air Conditioning Trainer

Text book / Reference books: None specified

Course Code: **FL 305**
Course Name: **French Language and Culture - V**
Credits: **0 (0-2-0)**
Course Position: **Semester 5**

Objectives:

At this level the students work in class on understanding and expressing feelings, intentions, opinions and routine tasks in order to interact with relative facility in their specific field of activities. Students are able to discuss ideas with frequently used language and can ask for information about familiar subjects concerning everyday subjects and the news. They also work on comprehension skills and writing notes. They work on improving their grasp of everyday syntax and grammar and build a lexical base corresponding to immediate needs. They also work on targeted pronunciation to improve clarity of expression.

Course Content:

A) Topics

1. To accept or to refuse any invitation
2. Showing possession
3. Description of an object
4. Expressing comparison
5. To express an idea
6. Description of a landscape

B) Grammar

1. Revision of l'imparfait (Past Continuous), le Futur simple (Simple future) et le passé composée (Simple Past)
2. Possessive Pronouns
3. Place of Adjectives
4. Recent Past
5. Forms of negation

C) Types of writing

1. Informal letter or email
2. A short passage

Course No: **ME 310**
Course Name: **Multiphysics**
Credits: **4 (3-1-0)**
Course Position: **Semester 6**

Course Content:

Module 1:
Mathematical preliminaries: Vector algebra and Indicial notation, Tensors – properties and calculus.
Configurations and motion: Lagrangian and Eulerian descriptions, Equivalence, Material and spatial derivatives.

Module 2:
Kinematics of Continuous media: Deformation and displacement gradient tensor, Lagrangian and Eulerian strain measures, Linearized strain measures – small strain tensor.

Module 3:
Traction vector and stress tensor – properties.

Module 4:
General principles: Conservation and balance laws – Conservation of mass, continuity equation, Balance of momenta and energy, Reynold's transport theorems.

Module 5:
Boundary value problems. Thermo-Elasticity: Classical elasticity, Generalized Hooke's law, isotropy, thermal stresses and strain.
Electro-Elasticity: Origins of Piezoelectric effect, Linear piezoelectricity.

Module 6:
Thermo-Electric phenomena: Joule heating phenomenon.
Thermo-Diffusive phenomena: Diffusion, Fick's laws, Effect of temperature, Coupled temperature-diffusion phenomena, Industrial applications.

Course Code: **ME 311**
Course Name: **Thermal Engineering**
Credits: **4 (3-1-0)**
Course Position: **Semester 6**

Course Content:

Module 1: Gas Power Cycles
Otto, Diesel, Dual Combustion cycles, Stirling Cycle, Atkinson Cycle, Ericsson Cycle, Joule Cycle Description and representation on P-V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis comparison of Cycles.

Module 2: Vapour Power Cycles
Carnot vapour power cycle, Rankine cycle, Mean Temperature of Heat Addition, Modified Rankine Cycle, Deviation of actual cycle from Idea cycle, Reheat cycle, Regenerative cycle, Multi stage regenerative cycle

Module 3: Refrigeration and Air-Conditioning
Introduction, Reversed Carnot cycle, Reversed Brayton cycle, Bell-Coleman cycle, Simple Vapour compression system, Analysis of simple vapour compression system, Vapour absorption refrigeration system, Multi stage refrigeration system, Specific humidity, relative humidity, Specific properties of moist air, Air conditioning system, Psychometric chart.

Module 5: Heat Exchangers
Notions of heat exchangers. Temperature fields in co- and counter-flow heat exchanger, LMTD and NTU analysis of heat exchanger, Exchanger efficiency.

Module 6: Positive Displacement Machines
Reciprocating compressors, Reciprocating compressors including clearance, Multi-stage compression.

Module 7 (optional): Nozzles and Jet Propulsion
Nozzle shape, Critical pressure ratio, Maximum mass flow, Nozzle Efficiency, The steam nozzle, Stagnation conditions, Jet propulsion, The Turboprop.

Text Book:

- Nag P K, “Engineering Thermodynamics”-Tata McGraw Hill, New Delhi.
- Cengel, “Thermodynamics - An Engineering Approach”, Tata McGraw Hill, New Delhi
- Moran and Shapiro, Principles of Engineering Thermodynamics”, John Wiley & Sons

References:

- Sonntag, R. E., Borgnakke, C., & Wylen, G. J. V. Fundamentals of thermodynamics : Wiley.
- Jones, J. B., & Dugan, R. E. Engineering thermodynamics : Prentice Hall.

- Potter, M. C., & Somerton, C. W . Schaum's O utline of Thermodynamics for Engineers, McGraw-Hill.
- T.D. Eastop, A. McConkey, Applied Thermodynamics for Engineering Technologists: Pearson

Course Code: **ME 312**
Course Name: **Finite Element Methods**
Credits: **4 (3-0-2)**
Course Position: **Semester 6**

Module 1:

Introduction to Finite Element Method for solving field problems. Variational principles and weighted residual techniques for one-dimensional equation, Rayleigh-Ritz Formulation, development of bar and beam element, application to truss and frames.

Module 2:

Finite elements for two-dimensions: Equivalence between energy formulation and Galerkin approach, discretization concepts, choice of elements, derivation of element shape functions (Lagrangian and Hermite) in physical coordinates, Iso-parameteric mapping, numerical integration, Assembly procedure, solution techniques. Mesh generation, convergence analysis, and discretization errors.

Module 3:

Steady State Heat Transfer Analysis**:** one dimensional analysis of Slab, fin and two dimensional analysis of thin plate.

Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with Isoparametric triangular and quadrilateral elements.

Module 4:

Dynamic Analysis: Formulation of finite element model, element – mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, truss.

Module 5:

Introduction to finite element programming – Applications to problems in engineering: plane elasticity, heat conduction, potential flow and transient problems using commercial software.

Text Books:

1. R. D. Cook, D. S. Malkus, M. E. Plesha and R. J. Witt, Concepts and applications of Finite Element Analysis.

2. P. Seshu, Finite element analysis

Reference Books:

1. Chandrupatla T.R., and Belegundu A.D., Introduction to Finite Elements in Engineering, Pearson Education

2. David V Hutton, Fundamentals of Finite Element Analysis McGraw-Hill Int. Ed.

3. Rao S.S. The Finite Element Method in Engineering, Pergammon Press.

4. Logan D.L., A First course in the Finite Element Method, Third Edition, Thomson Learning,

5. Reddy J.N, An Introduction to Finite Element Method, McGraw-Hill International Student Edition

6. O.C.Zienkiewicz and R.L.Taylor, The Finite Element Methods, Vol.1. The basic formulation and linear problems, Vol.1, Butterworth Heineman.

7. R. MacNeal. Finite Elements: their Design and Performance . Marcel Dekker, Inc., New York, 1994.

8. T. Hughes. The Finite Element Method, Linear Static and Dynamic Finite Element Analysis, Prentice-Hall International, 1987.

9. K. Bathe. Finite Element Procedures in Engineering Analysis . Prentice-Hall Inc., Englewood Cliffs, NJ, 1982

Course Code: **ME 313**
Course Name: **Structural Dynamics and Acoustics**
Credits: **4 (3-1-0)**
Course Position: **Semester 6**

Course Content:

Module 1:
Introduction to Simple Harmonic Motion, Un-damped free vibration of a SDOF system, D'Alemberts principle, Springs in Series and Parallel, energy exchange principles, Solving a second order differential equation, Damping and its properties, Damped free vibration of a SDOF system, Damping ratio, Logarithmic Decrement

Module 2:
Forced Vibration, Solutions involving CF & PI, Frequency Response Curves, Magnification Factor, Phase Difference plotted against frequency ratios, Displacement & Force Transmissibilities – Vibration isolation, Impulse, Response due to Impulse

Module 3:
Two DOF systems, principal modes of vibration, symmetric & anti-symmetric modes, Vibration Absorber, Static & Inertial Coupling, Matrix Methods in Vibrations, Characteristic Equation, Eigen Values and Eigen Vectors, Approximate methods to find frequencies

Module 4:
Multi DOF Systems, Orthogonalities of Eigen vectors, Modal Decomposition, Continuous Systems – Bars, Beams and Bars subjected to extensions, beams subjected to bending & torsion, vibrations of a string,

Module 5:
Whirling of Shafts, Critical Speed, Shafts with single / multiple rotors, Electrical analogy, Condition Monitoring

Module 6:
Random vibrations: stationary random forces, power-spectral density, response of a SOF to stationary random forces, cross-power spectra, identification of the frequency response.

Module 7:
Acoustics: models and sources, propagation, resonances, Introduction to fluid-structure interaction: light and heavy fluid approximations

Textbook:

Vibration of Mechanical Systems, Alok Sinha, Cambridge University Press

References:

- Theory of Vibrations with Applications, William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, Pearson
- Engineering Vibration, Daniel J. Inman, Pearson
- J. L. Meriam and L. G. Kraige, Engineering Mechanics: Dynamics, 6th ed., Wiley India Pvt. Ltd.
- F. P. Beer and E. R. Johnston Jr., Vector Mechanics for Engineers: Statics and Dynamics, 6th ed., The McGraw-Hill Companies 2001.
- H. Goldstein, Classical Mechanics, 3rd ed., Pearson Education, 2011
- L. A. Pars, Introduction to Dynamics, Cambridge University Press, 1953
- H. Baruh, Analytical Dynamics, McGraw-Hill, 1999
- E. T. Whittaker, A Treatise on the Analytical Dynamics of Particles and Rigid Bodies, Cambridge University Press, 4th revised ed. (1937)
- M. Géradin and D. Rixen. Mechanical Vibrations. Theory and Application to Structural Dynamics. John Wiley.
- R. Clough and J. Penzien. Dynamics of structures. McGraw-Hill, New York, 1975.
- D. Inman. Engineering Vibration. Prentice-Hall, Englewood Cli_s, N.J., 1994.
- Y.K. Lin & G.Q. Cai. Probabilistic structural dynamics. MacGraw-Hill, 1995.

Course Code: **PR 301**
Course Name: **Third year team project**
Credits: **3 (0-0-6)**
Course Position: **Semester 6**

Course Content:

Develop a set of key skills to become an innovative engineer:

Teamwork: organize, decide, manage within a team; team member roles and performance

Written and oral communication: structure and synthesis, increase written and oral impact, interpersonal communication and public communication

Approach to solve complex problems: frame the issue; inductive, experimental and recursive approaches; doubt and complexity

Creativity: group creativity methods

Build one's academic and career plan

Discover the work of an engineer

Text Book:

Case studies based teaching and problem based learning

References:

- A Guide to the Project Management Body of Knowledge: PMBOK Guide (Fifth Edition), PMI Project Management Institute.
- Project Management: A Systems Approach to Planning, Scheduling, and Controlling (11th Edition), Harold Kerzner.
- Managing Complex Projects (The IIL/Wiley Series in Project Management) International Institute for Learning, Harold R. Kerzner, Carl Belack.
- Project Management: from Simple to Complex, v. 1.0; Russell Darnall and John M. Preston.

Course Code: **FL 306**
Course Name: **French Language and Culture - VI**
Credits: **0 (0-2-0)**
Course Position: **Semester 6**

Objectives:

At this level the students work in class on understanding and expressing feelings, intentions, opinions and routine tasks in order to interact with relative facility in their specific field of activities. Students are able to discuss ideas with frequently used language and can ask for information about familiar subjects concerning everyday subjects and the news. They also work on comprehension skills and writing notes. They work on improving their grasp of everyday syntax and grammar and build a lexical base corresponding to immediate needs. They also work on targeted pronunciation to improve clarity of expression.

Course content:

A) Topics

1. To Propose or to invite for a program, a party etc.
2. Writing a personal letter
3. Expressing obligation and interdiction
4. To ask for the touristic information
5. To present one's point of view and argue about it
6. To understand the difference between written and spoken language

B) Grammar

1. Adverb
2. To know how to change verbs into noun and vice-versa
3. The Subjunctive
4. Relative pronouns
5. Expression of duration
6. Direct and Indirect speech in present
7. Basic logical connective

C) Types of writing

1. A short essay
2. Informal letter or email
3. Film review

Course Code: **ME 414**
Course Name: **Control Theory**
Credits: **3 (3-0-0)**
Course Position: **Semester 7**

Course Content:

- Introduction to control systems.
- Mathematical modelling of control systems.
- Transient and steady state response analysis.
- Control system analysis and design by the Root-locus method.
- Control system analysis and design by the Frequency Response method.
- PID controllers and modified PID controllers.
- Control system analysis in State Space.
- Control system design in State Space.

Text/Reference Books:

- Katsuhiko Ogata, Modern Control Engineering, 5th ed., Prentice-Hall, 2010, ISBN 10: 0-13-615673-8

Course Code: **ME 415**
Course Name: **Industrial Engineering**
Credits: **3 (3-0-0)**
Course Position: **Semester 7**

Course Content:

- Module 1: General introduction, systems and processes: systems; processes; economic, environmental and societal values
- Module 2: Demands engineering, conception processes: system engineering, V cycle, function analysis, AMDEC, life product cycle, conception processes
- Module 3: Industrialization, production: specialized workshops, line of production, MRP, just-in-time, lean, 6sigma, production costs, prices
- Module 4: Supply chain: supply networks, logistical chain, supply decision, operations management, vehicle round problem, shortest way problem
- Module 5: Running, SLI, after sales service: integrated logistical support, owning global cost, maintenance, work safety, availability, reliability, default rate.

Text Book:

- Introduction to Industrial and Systems Engineering, 3/E by W. C. Turner, J. H. Mize, K. E. Case, and J. W. Nazemt, Pearson Higher Education, Prentice Hall, 1993

References:

- Industrial Engineering and Production Management, 2nd ed., by. M. T. Telsang, S. Chand, 2006

Course Code: **PR 402**

Course Name: **Year-4 Project**

Credits: **3 (0-1-4)**

Course Position: **Semester VII**

The course consists of a two semester-long project on a topic given by a company or a tutor. Teams of 4 or 5 students will work on the actual need of this so-called client. Each project is linked to a specific challenge: Energy, Transportation, Health and other Thrust Areas.

Students will have inputs during the semester regarding their professional skills. They will work mostly in autonomy but monitored by regular project reviews.

The objective of Year-4 Project Work & Dissertation is to enable the student to take up, either fully theoretical or practical work or involving both theoretical and practical work, under the guidance of a Supervisor from the Department, alone, or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. Review and finalization of the Approach to the Problem relating to the assigned topic;
2. Preparing an Action Plan for conducting the investigation, including team work;
3. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
4. Final development of product/process, testing, results, conclusions and future directions;
5. Preparing a paper for Conference presentation/Publication in Journals, if possible;
6. Preparing a Dissertation in the standard format for evaluation;
7. Final Seminar presentation before a Committee.

Course Code: **FL 407**
Course Name: **French Language and Culture – VII**
Credits: **0 (0-2-0)**
Course Position: **Semester 7**

Objectives:

The aim is to place the students in various communication situations in French that correspond to social and professional contexts. They learn to express their ideas simply and coherently and are able to understand selective authentic French texts written in everyday language. These texts usually discuss subjects of cultural nature. Radio and television documentaries about the news or subjects linked to the students' specific area of interest are used to practice extracting key information. Students acquire sufficient vocabulary and control of the main grammatical structures to be able to express most of what they want to say relatively easy.

Course Content:

A) Topics

- Intergeneration accommodation
- Internet and cellphone
- Pollution
- Love, marriage, divorce
- Carpool (Covoiturage)

The topics were studied through written articles, audio listening and television coverage. Students were also asked to do oral presentations on the above mentioned topics.

B) Grammar

- Subjunctive
- Reported speech
- Connectors

C) Types of writing

- Official letter
- Argumentative essay

Course Code: **PR 403**

Course Name: **Year-4 Project**

Credits: **9 (0-5-8)**

Course Position: **Semester VIII**

The object of Year-4 Project Work & Dissertation is to enable the student to extend further the investigative study taken up under, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from a School at MEC or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

8. Review and finalization of the Approach to the Problem relating to the assigned topic;
9. Preparing an Action Plan for conducting the investigation, including team work;
10. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
11. Final development of product/process, testing, results, conclusions and future directions;
12. Preparing a paper for Conference presentation/Publication in Journals, if possible;
13. Preparing a Dissertation in the standard format for evaluation;
14. Final Seminar presentation before a Committee.

Course Code: **FL 408**
Course Name: **French Language and Culture - VIII**
Credits: **0 (0-2-0)**
Course Position: **Semester 8**

Objectives:

The aim is to place the students in various communication situations in French that correspond to social and professional contexts. They learn to express their ideas simply and coherently and are able to understand selective authentic French texts written in everyday language. These texts usually discuss subjects of cultural nature. Radio and television documentaries about the news or subjects linked to the students' specific area of interest are used to practice extracting key information. Students acquire sufficient vocabulary and control of the main grammatical structures to be able to express most of what they want to say relatively easy.

Course Content:

A. Topics

- French education system
- Employment/Unemployment
- House exchange

The topics were studied through written articles, audio listening and television coverage. Students were also asked to do oral presentations on the above mentioned topics.

B. Grammar

- Future perfect
- Nominalization

C. Types of writing

- Article for magazine
- Writing/ Responding to queries on forum discussion platforms

Course Code: **ME 450**
Course Name: **Refrigeration & Air Conditioning**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Part A: Refrigeration

Module 1: Introduction- Necessity and applications; Module of refrigeration and C.O.P. Mechanical Refrigeration; Types of Ideal cycles of refrigeration. Air Refrigeration: Bell Coleman cycle and Brayton Cycle, Open and Dense air systems ; Actual air refrigeration system problems ; Refrigeration needs of Aircrafts.

Module 2: Vapour Compression Refrigeration- Working principle and essential components of the plant ;Simple Vapour compression refrigeration cycle ;COP ;Representation of cycle on T-S and h charts ;effect of sub cooling and super heating ; cycle analysis; Actual cycle Influence of various parameters on system performance; Use of p-h charts; numerical Problems.

Module3: Refrigeration System Components-Compressors; General classification; comparison; Advantages and Disadvantages. Condensers:– classification ;Working Principles. Evaporators:– classification ; Working Principles. Expansion devices:– Types ; Working Principles. Refrigerants:– Desirable properties ; classification refrigerants used ; Nomenclature; Ozone Depletion; Global Warming.

Module 4: Vapor Absorption Refrigeration- Calculation of max COP; description and working of NH3; water system and Li Br; water (Two shell & Four shell) System. Principle of opération Three Fluid absorption system, salient features.

Module 5: Other Refrigeration Systems- Steam Jet Refrigeration System; Working Principle and Basic Components. Principle and operation of (i) Thermoelectric refrigerator (ii) Vortex tube or Hilsch tube.

Part B: Air Conditioning

Module 1: Introduction- Psychometric Properties & Processes; Characterization of Sensible and latent heat loads; Need for Ventilation, Consideration of Infiltration; Load concepts of RSHF, GSHF- Problems, Concept of ESHF and ADP. Requirements of human comfort and concept of effective temperature; Comfort chart; Comfort Air conditioning; Requirements of Industrial air conditioning ;

Module 2: Air Conditioning System Components -Equipment for cooling, heating humidification and dehumidification, filters, grills and registers, fans and blowers. Heat Pump; Heat sources, different heat pump circuits.

Text/Reference Books:

- Manohar Prasad, Refrigeration and air conditioning: New Age International, 2003.
- Stoecker, W. F., & Jones, J. W. Refrigeration and air conditioning: McGraw-Hill.
- Lumley, J. L;Engines: an introduction: Cambridge University Press.
- Ferguson, C. R., & Kirkpatrick, A. T. Internal combustion engines: applied thermosciences: John Wiley.
- Stone, R. Introduction to internal combustion engines:
- Whitman, W. C., Johnson, W. M., & Tomczyk, J. Refrigeration & air conditioning technology: Delmar
- Dossat. Principles of Refrigeration: Pearson Education.

Course Code: **ME 451**
Course Name: **Advanced Manufacturing Engineering**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

Metal Casting: Gating design, cooling and solidification especially for center line feeding resistance, continuous casting process, riser design and placement.

Forming: Mechanics of metal forming processes. Analysis of strip rolling, wire drawing, extrusion, strip forging.

Joining: Analysis of either one of thick plate welding or thin plate welding.

Machining and Machine Tool Operations: Cutting force analysis for single point and multipoint tools. Machine tool vibrations (chatter theory).

Non-conventional Machining processes: Several non-conventional processes will be covered based on the preferences of the individual instructor. Suggested processes include EDM & WEDM, ECM, USM, AJM, WJM, LBM, EBM, PAM, etc.

Text Book:

- Manufacturing Science by A. Ghosh and A.K. Mallik, Affiliated East-West Press Pvt.Ltd., 2nd Edition, 2010, ISBN 978-81-7671-063-3

References:

- Manufacturing Processes for Engineering Materials by Serope Kalpakjian and Steven R. Schmid, Pearson Education Inc., 2013, 5th Edition ISBN: 978-81-317-0566-7
- Fundamentals of Metal Machining and Machine Tools by G. Boothroyd, McGraw Hill, Inc.
- Metal Casting: Computer Aided Design and Analysis by B. Ravi, PHI Learning Pvt. Ltd., 2005, ISBN: 8120327268, 9788120327269
- Modern Machining Processes by P. C. Pandey and H. S. Shan, Tata McGraw-Hill Publ. Co., 2008, ISBN13: 978-0-07-096553-9

Course Code: **ME 452**
Course Name: **Introduction to Operations Research**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Module1: Overview of Operations Research Modeling

Module 2: Linear programming : The Simplex Method, Duality and Sensitivity Analysis.

Module 3 : Other algorithms for linear programming such as the Dual Simplex method, Parametric Linear Programming, The Upper Bound Technique, etc.

Module 4: The Transportation and Assignment Problems

Module 5: Network Optimization Models

Module 6: Project Management with PERT/CPM

Module 7: Rudiments of a few of the following topics : Dynamic programming, Integer programming, Nonlinear programming, Game theory, Markov Chains, Queueing theory, Inventory theory, and Forecasting.

Text/ Reference Books:

- Taha, H. A., Operations Research : An Introduction, 9th ed., Prentice Hall, 2010
- Bronson, R. and Naadimuthu, G., Schaum's Outline of Operations Research, The McGraw-Hill Companies, Inc., 1997

Course Code: **ME 453**
Course Name: **Dynamics and Applications**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Rotations:

Euler's representation, composition of rotations, Euler angles, Euler parameters, quaternions, time derivatives, angular velocity

Constraints:

Holonomic and non-holonomic constraints, constraints for particles and rigid bodies, Frobenius theorem on integrability, constraint forces and moments, rolling and sliding contact

Newtonian Dynamics:

Newtonian equations of motion, inertia tensor, principal axis of inertia, angular momentum, Newton-Euler equations for a rigid body, rotation about a fixed point, study of rolling sphere, rolling coin, top and gyroscope

Lagrangian Dynamics:

Lagrangian equations of motion for particles and rigid bodies, constraints using curvilinear coordinates, rotation about a fixed point, study of rolling sphere, rolling coin, top and gyroscope

Textbook:

O. M. O'Reilly, Intermediate Dynamics for Engineers, Cambridge University Press, 2008.

Reference Books:

J. L. Meriam and L. G. Kraige, Engineering Mechanics: Dynamics, 6th ed., Wiley India Pvt. Ltd.

F. P. Beer and E. R. Johnston Jr., Vector Mechanics for Engineers: Statics and Dynamics, 6th ed., The McGraw-Hill Companies 2001.

H. Goldstein, Classical Mechanics, 3rd ed., Pearson Education, 2011

L. A. Pars, Introduction to Dynamics, Cambridge University Press, 1953

H. Baruh, Analytical Dynamics, McGraw-Hill, 1999

Course Code: **ME 455**
Course Name: **Turbomachinery**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Introduction to Turbomachines. Classification of Turbomachines. Second Law of Thermo dynamics, turbine/compressor work, Nozzle/diffuser work. Fluid equations: continuity, Euler's, Bernoulli's equation and its applications. Expansion and compression processes, Reheat Factor, Preheat Factor.

Euler's Equation of Energy Transfer, vane congruent flow, influence of relative circulation, thickness of vanes, number of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje's slip factor. Suction pressure and net positive suction head. Phenomena of cavitation in pumps. Concept of specific speed, Shape number. Axial, Radial and Mixed Flow Machines. Similarity laws.

Flow through Axial flow fans. Principles of Axial fan and propeller. Application of fans for air circulation and ventilation. Stage pressure rise and work done. Slip stream and Blade Element theory for propellers. Performance and characteristics of Axial fans.

Flow through Centrifugal compressors. Stage velocity triangles, specific work. forward, radial and backward swept vanes. Enthalpy entropy diagram, degree of reaction, slip factor, efficiency. Vane less and vaned diffuser systems, volute as spiral casing. Surge and stall in compressors

Axial turbine stages, stage velocity triangles, work, efficiency, blade loading, flow coefficient. Single stage impulse and reaction turbines, degree of reaction, 50% reaction turbine stage, Radial equilibrium and Actuator disc approach for design of turbine blades. Partial admission problems in turbines. Losses in turbo machines.

Text book:

An Introduction to Energy Conversion: Turbomachinery, Volume 3

Reference books:

Sheppard, Principles of Turbomachinery.

R.K.Turton, Principles of Turbomachinery, E & F N Spon Publishers, London & New York.

Course Code: **ME 456**
Course Name: **Systems Engineering**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Introduction to Systems through examples, Systems Engineering Overview, System of Systems, Generic Life-Cycle Stages, the V-cycle model, alternative approaches.
Technical Processes: Requirements Definition and Analysis, System Design Specifications, Architectural Design, Sub-system Design Specifications, Verification, Implementation, Modular Integration, Validation, Deployment, Operation and Maintenance.
Project Processes: Planning, Assessment, Control, Decision- , Risk- , Configuration- and Information- Management Processes, Measurement Process.
Organization Project-enabling Processes: Life-Cycle Management Process (MP), Infrastructure MP, Project Portfolio MP, Human Resource MP, Quality MP.
Experiments: Strategy, Design, Analysis.

Textbooks:

1. INCOSE (International Council of Systems Engineering) *Systems Engineering Handbook v.3.2.2*, Oct 2011, or latest versions.
2. Blanchard, B. S., and Fabrycky, W. J., *Systems Engineering and Analysis*, 5th edition, Prentice Hall, 2010.
3. *Systems Engineering for Dummies*, IBM, John Wiley and Sons, 2012.

Course Code: **ME 457**
Course Name: **Advanced Mechanics of materials**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Contents

Module 1

Introduction to types of composite materials, Advantages of Fibre Reinforced Composites, Macromechanical behaviour of a lamina, Stress-strain relations, Stiffness and compliances for orthotropic and anisotropic materials, Plane stress conditions, strength and strength criteria for an orthotropic lamina.

Module 2

Introduction to micromechanical behaviour of a lamina, Mechanics of materials approach to stiffness and strength.

Module 3

Macromechanical behaviour of a laminate, Lamination theory, stiffness and strength of laminates.

Module 4

Introduction to fatigue of metallic materials and microscopic origins of fatigue, Total life approaches, Stress-life relations – Basquin's equation, S-N diagrams, Mean stress effects, Soderberg, Goodman and Gerber criteria.

Module 5

Strain-Life approaches, Cyclic stress strain behaviour – hardening and softening, Stable cyclic hysteresis, Massing's hypothesis, Coffin – Manson's law, Strain- Life relations.

Teaching Material and Textbooks

- Robert M. Jones, Mechanics of Composite Materials, Taylor & Francis
- Bannantine J.A et al, Fundamentals of Metal Fatigue Analysis, Prentice Hall

Course Code: **ME 458**

Course Name: **Introduction to IC Engines**

Credits: **3 (3-0-0)**

Course Position: **Semester 6, 7 or 8**

Course Content:

Module 1: Basic Concepts-Air standard cycles and fuel-air cycles Assumptions, Otto, Diesel & Dual cycles, comparison of cycles, fuel air cycle, Valve Timing diagram, Actual engine cycle.

Module 2: S.I. Engines- Theory of Carburetion, Types of carburettors, Electronic fuel injection system, GDI. Combustion in spark Ignition engines, stages of combustion, flame propagation, rate of pressure rise, abnormal combustion. Phenomenon of Detonation in SI engines, effect of engine variables on Detonation. Combustion chambers. Rating of fuels in SI engines. Additives.

Module 3: C.I. Engines- Fuel supply system, types of fuel pump, injector and distribution system, Combustion in compression ignition engines, stages of combustion, factors affecting combustion, Phenomenon of knocking in CI engine. Effect of knocking. Types of combustion chambers rating of fuels in CI engines. Additives; Comparison of knocking in SI & CI engines, Concepts of Supercharging and Turbo charging.

Module 4: Engine systems and components-Ignition system.(battery, magneto & electronic); Lubrication system; Engine starting system; Engine cooling system; Governing system (quality and quantity hit & miss governing); Intake and exhaust systems (two valves & four valves); Drive train (cam shaft, valves etc.)

Module 5: Performance characteristics & Testing of I.C. Engines-Introduction to Indian. Standards for testing of I.C. Engine, Mean effective pressure, indicated power, brake power, friction power, Methods to determine power and efficiencies Variables affecting performance of engine, characteristic curves, heat balance sheet, Methods of improving engine performance; super & turbocharged engines.

Module 6: Fuels and Emissions- Chemical structure of the Petroleum, Refining process for petroleum, important qualities of the Engine fuels - (SI & CI engines), Diesel, and Gasoline fuels- Indian specifications. Alternate fuels (SI & CI engines)- Liquid fuels, gaseous fuels, hydrogen engines (LPG, HC NG (15%, 20%, 25 % Blends Hydrogen and Biofuels), Air pollution due to IC engine, Engine emissions, Hydrocarbon emissions, (HC) & PPM & Carbon monoxide émissions (CO), oxides of Nitrogen (NOx) Euro norms , Bharat stage norms, Introduction to EDC and IDC ,

Introduction to carbon credit, Emission control methods for SI and CI engines, Electronic control module, Catalytic converters, EGR Concept of hybrid vehicles.

Text/Reference Books:

- Ganesan.V. Internal combustion engines: Tata Mcgraw-Hill Publishing Company Limited.
- Heywood, J. B. Internal combustion engine fundamentals: McGraw-Hill.
- Lumley, J. L;Engines: an introduction: Cambridge University Press.
- Ferguson, C. R., & Kirkpatrick, A. T. Internal combustion engines: applied thermosciences: John Wiley.
- Stone, R. Introduction to internal combustion engines:

Course Code: **ME 459**
Course Name: **Power Plant Engineering**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Module 1: Introduction to Power Plants and Boilers
Layout of Steam , Hydel , Diesel , MHD, Nuclear and Gas turbine Power Plants.

Combined Power cycles: comparison and selection;, Load duration curves, Steam boilers and cycles, High pressure and Super Critical Boilers, Fluidised Bed Boilers

Module 2: Steam Power Plants
Fuel and ash handling ,Combustion Equipment for burning coal, Mechanical Stokers. Pulveriser, Electrostatic Precipitator, Draught- Different Types, Surface condenser types, cooling Towers

Module 3: Nuclear Power Plants
Nuclear Energy-Fission , Fusion Reaction, Types of Reactor, Pressurized water reactor, Boiling water reactor, Waste disposal and safety

Module 4: Hydel Power Plants : Essential elements, Selection of turbines, governing of Turbines,

Module 5: Diesel and Gas Turbine Power Plants
Types of diesel plant, components , Selection of Engine type. Gas turbine power plant: Fuels, Gas turbine material, Open and closed cycles, Reheating, Regeneration and Intercooling, Combined cycle

Module 6: Non-traditional Power Plants: Geo thermal, Tidal, and Solar Power Plants

Module 7: Economics of Power Plants: Cost of electric Energy, Fixed and operating costs, Energy rates, Types tariff, Economics of load sharing, Comparison of various power plants.

Text book:

Nag P.K , Power Plant Engineering. 3rd edition Tata McGraw- Hill ,2007

Reference Books:

1. EI-Wakil M.M , Power Plant Technology, Tata McGraw-Hill 1984
2. K.K.Ramalingam , Power Plant Engineering, Scitech Publications, 2002

Course Code: **ME 460**
Course Name: **Alternative Energy Sources**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Nuclear:
Nuclear Energy-Fission , Fusion Reaction, Types of Reactor, Pressurized water reactor, Boiling water reactor, Waste disposal and safety

Solar Energy:
Solar radiation data, solar energy conversion into heat, collectors, Photo voltaics - Solar cells, PV systems. Grid integration.

Wind Energy:
Energy available from wind. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed. Horizontal and Vertical axis windmill rotors. Working principle of wind power plant.

Tidal & Geothermal:
Definition and classification of Geothermal resources, Utilization for electricity generation and direct heating. Basic features: Atmospheric exhaust and condensing, Exhaust types of conventional steam turbines.
Principles of tidal and wave power generation, OTEC power plants, Operation of small open-cycle facility. Economics of OTEC.

Fuel cells:
Introduction and overview of fuel cells technology: low and high temperature fuel cells, Fuel cell thermodynamics, Fuel cell reaction kinetics: Introduction to electrode kinetics, Safety issues and cost expectation and life cycle analysis of fuel cells.

Textbook:

No textbook is specified.

Course Code: **ME 462**
Course Name: **Composite Materials**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Introduction:
Application of Composite Materials to Aerospace and Automobile industries.
Classification based on matrix and topology, Constituents of composites.

Fabrication:
Polymer Composites – Selection of matrix, Moulding methods, Control of particle/fibre and porosity content, particle/fibre distribution, Interfacial Reaction of matrix-reinforcing component.
Metal Matrix Composites: Selection of constituents, solidification and Dispersion Processes, rheological behaviour of melt particle slurry.

Mechanical behaviour of Composites:
Strength analysis (Law of Mixtures, Laminated plate model).
Strengthening mechanisms, Stress distribution in fibre and the matrix, critical length and amount of fibre for full strengthening,

Fracture of Composites:
Fracture behaviour of composites, Mechanics and Weakest link statistics, Griffith theory of brittle fracture and modification for structural materials, Fracture of metal matrix composites.

Textbooks / Reference books:

D. Hull and T. W. Clyne, An Introduction to Composite Materials, Cambridge University Press (2008)

Course Code: **ME 463**
Course Name: **Engineering Alloys in Design**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**
Course Content:

Module 1

Fe alloys:

Carbon steels, Stainless steels, Tool steels, bearing steels – Microstructure of steels and evolution of microstructure for different treatments. Phase transformations in steels. Impact of phase transformations and microstructure on the physical properties of steels. Annealing, quenching, tempering, aging, case hardening of gear steels. Stainless steels for surgical applications.

Module 2

Ni alloys:

Applications of Ni alloys – Turbines, Medical, Nuclear. Microstructure and precipitation in Ni alloys. Precipitation kinetics. Ni Superalloys.

Module 3

Ti alloys:

Microstructure and applications, typical alloying elements, Structural applications for high performance – strength/weight ratio in design, Corrosion resistance of Ti alloys, Ti alloys for biomedical applications.

Module 4

Lightweight (Al, Mg) alloys:

Applications of Al and Mg alloys – automobile industry, electronics industry. Importance of lightweight alloys. Precipitation hardening in Al and Mg alloys.

Module 5

Composite materials – advantages and fabrication methods for fibre reinforced polymer composites. Strength prediction of FRPs using rule of mixtures, Orthotropic nature of FRPs. Introduction to types and applications of Metal matrix and Ceramic matrix composite materials.

Textbooks / Reference books:

No textbook specified.

Course Code: **ME 465**
Course Name: **Flight Dynamics**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Introduction: Elements of an airplane, representative flight vehicles and the mechanics of flight.

The flight envelope: The atmosphere of the earth, kinematics, forces and moments, static aerodynamic coefficients, thrust characteristics of aircraft powerplants, and steady flight performance.

Aircraft motion dynamics: Momentum and energy, Dynamic equations for a flat earth and for a round, rotating earth, aerodynamic effects of rotational and unsteady motion, aerodynamic effects of control, solution of nonlinear differential equations.

Design and analysis methods: Local linearization of differential equations and their solution, stability and modes of motion, frequency domain analysis, dealing with uncertainty, linear aeroelasticity, flying qualities and flight control systems.

Longitudinal motions.

Lateral directional-motions.

Coupled longitudinal and lateral-directional motions

Text Book:

Robert F. Stengel, Flight Dynamics, Princeton University Press, 2004

References:

M. Abzug and E. Larrabee, Airplane Stability and Control: A History of the technologies that made aviation possible, Cambridge University Press, 2002

Course Code: **ME 466**

Course Name: **Aircraft Design**

Credits: **3 (3-0-0)**

Course Position: **Semester 6, 7 or 8**

Course Content:

- Introduction to the design process and phases in aircraft design.
- Sizing and weight estimation.
- Wing and thrust loading optimization. Engine selection.
- Airfoil and geometry (wing parameter) selection.
- Thrust to weight ratio.
- Configuration Layout. Location of engine and landing gear. Preliminary sizing of empennage.
- Estimation of weights of different components. Design of control surfaces.
- Miscellaneous topics.

Text / Reference Books:

- D. Raymer, Aircraft Design: A Conceptual Approach, AIAA Press, 1989, 2006
- L. Nicolai, Fundamentals of Aircraft Design, University of Dayton, Ohio, 1975
- J. P. Fielding, Introduction to aircraft design, Cambridge University Press, 1999

Course Code: **ME 467**
Course Name: **Introduction to Robotics**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Module 1(Introduction)

Introduction to Robotics, Robotics and AI, Introduction to ROS, 2D transforms, Homogenous Coordinates, 3D Transforms, Thinking about Transforms, Transform Inverse, Rotation Representations, Transforms in ROS, the TF library.

Module 2 (Kinematics)

Robot Arms Introduction, Kinematic Chains, Forward Kinematics: URDF, Forward Kinematics: Analytical Methods, DH Parameters, Forward Kinematics: DH Examples, Analytical IK, Robot Examples, Robot Workspaces and IK Solutions.

Module 3 (Differential Kinematics)

Differential Kinematics: Jacobian Definition and Analytical Computation, Singularities, Full Kinematics: Robot Examples.

Module 4 (Control)

Numerical Jacobian Computation, Cartesian and Null Space Control, Motion Planning: Configuration Space vs. Task Space, Stochastic Motion Planning.

Module 5 (Mobile robots and Path Planning)

Mobile Robots Introduction, Mobile Robots Kinematics: Differential Drive, Other Kinematics, Path planning for mobile robots, Robotics and AI.

Text Book:
Introduction to Robotics: C G Craig
Introduction to Robotics: Saeed B Niku.

Reference Book:
Lorenzo Sciavicco and Bruno Siciliano, *Modelling and control of robot manipulators*, Springer.
Mark W. Spong, Seth Hutchinson and M. Vidyasagar, *Robot Modeling and Control*, Wiley.

Course Code: **ME 468**
Course Name: **Introduction to Combustion**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Study of combustion science based on the background of chemistry, thermodynamics, fluid mechanics, heat and mass transfer.

Stoichiometry

Energetics of chemical reactions

Flame temperature

Equilibrium product analyses

Chemical kinetics

Chain reactions

Text / Reference Books:

Turns, S. R., An Introduction to Combustion: Concepts and Applications, Second Edition, McGraw-Hill, Boston, MA, (2000).

Course Code: **ME 469**
Course Name: **Computational Fluid Dynamics**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

Introduction (role of CFD, methodology, limitations)
Basic equations of fluid mechanics (conservation laws, incompressibility, moving control volumes)
Levels of approximations to the basic equations (Navier-Stokes equations, DNS, LES, RANS, boundary layer approximation, inviscid flows)
Mathematical nature of the flow equations and boundary conditions (convection-diffusion equation, partial differential equation of second order, hyperbolic/ parabolic/ elliptic equations, conservation form of the equations)
Finite difference method on structured grids (order of derivatives, order of accuracy, multi-dimensional space, non-uniform grids, centered and skewed stencils, implicit formulas)
Finite volume and finite element methods (conservative discretization, general formulation, practical implementation, estimation of gradients, weak formulation, weighted residuals, Galerkin method)
Structured and unstructured grid properties (non-uniform, body-fitted, multi-block, tetrahedral and hexahydral, hybrid, evaluation of cell areas and volumes, best practice)
Consistency, stability and error analysis (definitions, von Neumann stability analysis, new schemes for convection, spectral analysis of numerical errors, numerical oscillations)
General properties and high-resolution numerical schemes (two-level schemes, stability issues, generation of new schemes, monotonicity, Godunov's theorem, limiters)
Time integration methods for space-discretized equations (matrix representation of operators, eigenvalue spectrum, Fourier modes, stability regions, implicit and explicit schemes, predictor-corrector schemes, ADI method)
Iterative methods for the resolution of algebraic systems (point Jacobi and Gauss-Seidel, convergence analysis, overrelaxation, preconditioning, multigrid method)
Numerical simulation of inviscid flows (influence of compressibility, discontinuities, space discretization, time integration, boundary conditions)
Numerical solutions of viscous laminar flows (boundary conditions, grid, density-based methods, pressure correction methods, best practice)
Turbulence Modelling (RANS, LES, DNS), transition to turbulence.

Textbooks:

4. "*Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics*", C. Hirsch, 2nd ed., Butterworth-Heinemann.
5. “Computational Fluid Dynamics – The Basics with Applications”, J.D. Anderson, 1st Ed., McGraw Hill.

Course Code: **ME 470**
Course Name: **Robotics: Dynamics and Control**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Module 1: Introduction
Introduction and Course Overview: Introduction to the course goals and objectives and a review of rigid body transformations and kinematics. Rigid Body Dynamics: Newton-Euler equations and the basics of Lagrangian mechanics. Explanation of the derivation of the equations of motion for a quadrotor.

Module 2: Dynamics of Robot Arm
Dynamics of Robot Arms: The derivation of the equations of motion of a robot arm using Lagrangian mechanics. Introduction to Linear Control: Covers the basics of linear control including frequency domain analysis, PID control and feed-forward control.

Module 3: State Space Modeling and Multivariable Systems
State space, modeling and linear control of multi-variable systems. Nonlinear Control: Introduction to control of nonlinear systems with input-output linearization.

Module 4: Stability Theory
Lyapunov stability theory and nonlinear control of an n-link robot arm. Quadrotor Control: Develops a nonlinear controller for a quadrotor and discusses planning dynamically feasible trajectory.

Module 5: Trajectory Generation
Methods for generating smooth trajectories given boundary conditions and intermediate waypoints.

Text Book:
Introduction to Robotics: C G Craig
Introduction to Robotics: Saeed B Niku.

Reference Book:
Lorenzo Sciavicco and Bruno Siciliano, *Modelling and control of robot manipulators*, Springer.
Mark W. Spong, Seth Hutchinson and M. Vidyasagar, *Robot Modeling and Control*, Wiley.

Course Code: **ME 471**
Course Name: **Micro-scale Mechanics**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

INTRODUCTION (Size Effects, Volume-to-Surface Ratio, Applications, Fabrication Techniques)
SCALING EFFECTS (Nature, Geometry, Mechanical, Electrostatic, Fluid, Thermal)

MICROSCALE SOLID MECHANICS (Introduction, Elements of Elasticity Theory, Static Green's Functions, Eigenstrains, Analysis of Dislocations, Cracks, Inclusions and Inhomogeneities)

MICROSCALE FLUID MECHANICS (Introduction; Continuum Microscale Fluid Mechanics: Governing Equations, Constitutive Relations; Surface properties; Essentials and Electrokinetic Phenomena; Microfluidic components; Case Study)

MICROSCALE HEAT TRANSFER (Conduction Heat Transfer; Diffusion Mass Transfer; Convection Heat and Mass Transfer; Single Phase Liquid flow and Heat Transfer in Microchannels; Case Study);

APPLICATIONS (Biomedical applications, Micro Sensors, Micro Actuators, Microfluidic Controls for Internal and External Flows)

Text Books:

"Microsystem Design" by Stephen D. Senturia, Kluwer Academic Publishers, 2001.
"Micro and Smart Systems" by G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat, and V. K. Aatre, Wiley-India, 2010
"Essentials of Micro and Nano Fluidics", Conlisk.,
"Fundamentals and Applications of Microfluidics", Ngyuen et. al.,
"MEMS & Microsystems", TR Hsu
"Foundation of MEMS", C Liu.
"Micromechanics of Defects in Solids", Toshio Mura, Springer, 1982.

Course Code: **ME 472**
Course Name: **Theory of Elasticity**
Credits: **3 (3-0-0)**
Course Position: **Semester 6, 7 or 8**

Course Content:

General principles:

Stress-strain relations for elastic solids. Governing equations in Cartesian and polar coordinates. Existence and uniqueness of solutions. Superposition theorem. Maxwell-Betti reciprocal theorem. St. Venant's principle. Yield criteria.

Antiplane strain problems:

Governing equation. Solution using complex variable methods. Applications to solution of line load, dislocation, crack, circular hole and inclusion problems.

Plane strain problems:

Airy stress function. Solution of some problems in rectangular and polar coordinates using Airy stress function.

Torsion of non-circular sections:

St. Venant's theory. Prandtl stress function. Torsion of rectangular, elliptical and triangular cross-sections. Membrane analogy. Torsion of hollow thin-walled shafts.

Energy methods:

Work energy relation. Principle of virtual work. Principle of minimum potential energy. Principle of minimum complementary energy. Rayleigh-Ritz method, Castigliano's theorems.

Text Book

- Sadd, M. H. Elasticity: Theory, Applications and Numerics, 3rd Edition, Elsevier India, 2014

Reference Books

- Timoshenko, S. P., Goodier, J. N., Theory of Elasticity, Tata McGraw-Hill Education, 3rd Edition, 2010
- Srinath, L. S., Advanced Mechanics of Solids, Tata McGraw-Hill Education, 3rd Edition, 2008
- Bruhns, O. T Advanced mechanics of solids: Springer.
- Cook, R. D., & Young, W. C. Advanced mechanics of materials: Macmillan.
- Ugural, A. C., & Fenster, S. K. Advanced strength and applied elasticity: PTR Prentice Hall.
- Hartog, J. P. D. Advanced strength of materials: Dover Publications.

Course Code: **MA 450**

Course Name: **Numerical Linear Algebra**

Credits: **3 (3-0-0)**

Course Position: **Semester 6 or 8**

Introduction on vector and matrix norms, QR factorization and Least squares, Conditioning and stability, Solving system of equations, Eigen values, SVD. Iterative methods.

Text/Reference books:

1. Leader, Jeffery J. (2004). Numerical Analysis and Scientific Computation. Addison Wesley
2. Bau III, David; Trefethen, Lloyd N. (1997). Numerical linear algebra. Philadelphia: Society for Industrial and Applied Mathematics.
3. J. H. Wilkinson and C. Reinsch, "Linear Algebra, volume II of Handbook for Automatic Computation" SIAM Review 14, 658 (1972).
4. Golub, Gene H.; van Loan, Charles F. (1996), Matrix Computations, 3rd edition, Johns Hopkins University Press.

Course Code: **MA 451**

Course Name: **Meshfree Methods**

Credits: **3 (0-0-0)**

Course Position: **Semester 6 or 8**

Introduction, Positive Definite Functions, Scattered Data Interpolation with Polynomial Precision, Compactly Supported Radial Basis Functions, Reproducing Kernel Hilbert Spaces and Native Spaces for Strictly Positive Definite Functions, Least Squares RBF Approximation with MATLAB, Moving Least Squares Approximation, Approximate Moving Least Squares Approximation, Partition of Unity Methods, Approximation of Point Cloud Data IN 3D, Fixed Level Residual Iteration, Generalized Hermite Interpolation, RBF Hermite Interpolation in MATLAB, RBF Galerkin Methods and other topics.

Text/Reference books:

1. G. Fasshauer. (2007) Meshfree Approximation Methods with MATLAB, World Scientific.
2. H. Wendland. (2004) Scattered Data Approximation, Cambridge University Press.

Course Code: **MA 452**

Course Name: **Boundary Element Method and Boundary Integral Equations**

Credits: **3 (0-0-0)**

Course Position: **Semester 6 or 8**

Contents:

Introduction to Boundary element method, Fundamental solutions, Green's identities, Reciprocal relations, Boundary integral solutions, Boundary element solution with constant elements, Formulae for integrals of constant elements, Numerical examples, Boundary element solution with discontinuous linear elements, Formulae for integrals of discontinuous linear elements, Boundary element methods for two and three dimensional Laplace equations, Boundary element methods for Helmholtz equations, Green's function for potential problems.

Reference/ Text Book

1. WT Ang, *A Beginner's Course in Boundary Element Methods*, Universal Publishers,
2. C. Pozrikidis, A Practical guide to boundary element method.

Course Code: **MA 453**

Course Name: **PDE Based Image Processing**

Credits: **3 (0-0-0)**

Course Position: **Semester 6 or 8**

Image denoising using linear and nonlinear PDE filters; Variational methods in denosing; Image interpolation; Image segmentation: self snakes and active contours; Image in-painting, and De-blurring; numerical aspects of these filters.

Text/Reference books:

1. G. Aubert and P. Kornprobst (2006). Mathematical problems in image processing: Partial Differential Eqautions and the Calculus of Variations *Applied Mathematical Sciences 147*, Springer Publications
2. T.F. Chan, J. Shen, Image Processing and Analysis: Variational, PDE, Wavelet, and Stochastic Methods. SIAM publications (2005)
3. J. Weickert, Anisotropic diffusion in image processing, ECMI series Teubner, Stuttgart (1998)

Course Code: **MA 454**

Course Name: **Topology and Operator Theory**

Credits: **3 (0-0-0)**

Course Position: **Semester 6 or 8**

Topological spaces, continuity, connectedness, path-connectedness, compactness, product spaces, Tychonoff's theorem, and the Baire category theorem, Banach fixed point theorem and applications, uniform continuity and convergence, Algebraic Systems.
Elementary properties of Hilbert and Banach spaces. Orthonormal bases. Fourier expansions. Riesz representation theorem. The adjoint. Orthogonal projections. Spectral theory of bounded linear operators. The spectral theorem for compact self-adjoint operators. Applications to differential and integral equations, unbounded operators and applications; Fredholm operators.

References/ Text Books:

1.Introduction to Operator Theory I : Elements of Functional Analysis Authors: Brown, A., Pearcy, C.
2. Introduction To Topology And Modern Analysis, by G.F. Simmons
3. Topology: by J. R. Munkres.

Course Code: **MA 455**

Course Name: **Infinite dimensional Control Theory**

Credits: **3 (0-0-0)**

Course Position: **Semester 6 or 8**

Semigroup Theory, Reisz-spectral operators, Delay equations, Abstract Cauchy Problem, Perturbations and composite systems, Boundary control systems, Input-Output maps, Tests for approximate controllability and observability, Stability, Stabilizability, and Detectability, Compensator Design, Frequency-Domain Descriptions, Linear Quadratic Optimal Control, The problem on a finite-time interval, Controllability of Functional Differential Systems.

References/ Text Books:

1. “Infinite Dimensional Linear Systems Theory” (Lecture Notes in Control and Information Sciences) by R.F. Curtain and Pritchard.
2. "An introduction to infinite-dimensional linear systems theory" by Ruth F. Curtain, Hans Zwart.

Course Code: **MA 456**

Course Name: **Bayesian Statistics**

Credits: **3 (0-0-0)**

Course Position: **Semester 6 or 8**

1. The basics of Bayesian and Classical Statistics;
2. Bayesian Inference and the posterior distribution;
3. Point estimation, hypothesis testing, and the map rule;
4. Bayesian regression;
5. Perspectives on Bayesian Applications.

Text/Reference books:

1. Bertsekas, Dimitri, and John Tsitsiklis. *Introduction to Probability*. 2nd ed. Athena Scientific, 2008. ISBN: 9781886529236.

Course Code: **MA 457**

Course Name: **Financial Mathematics**

Credits: **3 (0-0-0)**

Course Position: **Semester 6 or 8**

1. Deterministic cash flow streams: The basic theory of interest; Fixed-Income Securities; The term structure of interest rates; Applied interest rate analysis.
2. Single-period random cash flows: Mean-variance portfolio theory; The capital asset pricing model; General Principles;
3. Derivative Securities: Forwards, futures, and swaps; Models of asset dynamics; Basic and advanced options topics.
4. General cash flow streams.

Text/Reference books:

1. David G. Luenberger. *Investment Science*. Oxford university press, 1998. ISBN: 9780195108095.

Course Code: **MA 458**

Course Name: **Nonlinear Conservation Laws and Applications**

Credits: **3 (0-0-0)**

Course Position: **Semester 6 or 8**

Course Contents:

1. Nonlinear hyperbolic systems in one space dimension: Linear hyperbolic systems with constant coefficients; Nonlinear case; Definitions and example; Simple waves and Riemann invariants; Shock waves and contact discontinuities; Characteristic curves and entropy conditions; Solution of the Riemann problem.
2. Gas dynamics and reacting flows: Entropy satisfying shock conditions; Solution of the Riemann problem.
3. Finite difference schemes for one-dimensional systems: Generalities on finite difference methods for systems; Godunov's method; Roe's method; Osher scheme; Flux vector splitting methods; Van Leer's second-order method; Kinetic schemes for the Euler equations.
4. Introduction to boundary conditions: The initial boundary value problem in the linear case; The nonlinear approach; Gas dynamics; Absorbing boundary conditions; Numerical treatment.

References:

1. E. Godlewski, P-A, Raviart. Numerical Approximation of Hyperbolic Systems of Conservation Laws, AMS 118, Springer.

2. R. J. LeVeque, Numerical Methods for Conservation Laws, ETH Zurich, Birkhauser.

3. C. M Defermos, Hyperbolic Conservation Laws in Continuum Physics, Springer.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR IMPROPER CONDUCT IN EXAMINATIONS
As guidelines for the disciplinary committee to recommend actions to the Director.

	Nature of Improper conduct	Punishment
	If the candidate:	
1.(a)	Possesses or keeps accessible in examination hall, any paper, book, programmable calculator, Cell phone, pager, palm computer or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculator, palm computer or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The Hall Ticket of the candidate will be cancelled.
3.	Impersonates any other candidate in connection with the	The candidate who has impersonated shall be expelled

	examination.	from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practical and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all the corresponding examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all the corresponding examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award	Cancellation of performance in that subject.

	pass marks.	
6.	Refuses to obey the orders of the Chief Superintendent or Assistant Superintendent or any officer on duty, or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in-charge or any person on duty in or outside the examination hall or causes any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge or any person on duty in or outside the examination hall or any of his relations or indulges in any other act of misconduct or mischief which results in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all the corresponding examinations. The continuation of

		the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If a student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clauses 6, 7 or 8.	Punishment for students of the college: Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. A person who does not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in an intoxicated condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared

		including practical examinations and project work of that semester/year.
12.	If any malpractice is detected, which is not covered in the above clauses 1 through 11, the same shall be reported for further action to award suitable punishment.	