# COURSE STRUCTURE & SYLLABUS

## MECHANICAL ENGINEERING

<table>
<thead>
<tr>
<th>Education</th>
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| In GOD's own land, a fusion of scholastic students, innovative & motivated researchers & teachers and fast moving visionary leaders. | PO- Yupia, Dist. – Papum Pare, Arunachal Pradesh, Pin – 791 112  
Ph No : 0360-2284801/2001582  
Fax No : 0360-2284972  
Email – nitarunachal@gmail.com |

<table>
<thead>
<tr>
<th>Ethics</th>
<th>Service to Society</th>
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<tbody>
<tr>
<td>Stepping Stone and Sky reaching ladder to success</td>
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To achieve the target of being a global leader in the field of Technical Education, there is some sort of time bound urgency to work quickly, massively and strongly, in respect of National Institute of Technology, Arunachal Pradesh being an “Institute of National Importance” (by an Act of Parliament) and being established only in five years back in 2010. I have therefore adopted a ‘B’ plan as stated below to achieve the primary goal of producing world class visionary engineers and exceptionally brilliant Researchers and Innovators:

In implementing the ‘B’ plan in letter and spirit, the framing of syllabi has been taken as an important legitimate parameter. Therefore, extraordinary efforts and dedications were directed for the last few years to frame syllabi in a framework which is perhaps not available in the country as of today, with an Indian perspective in a Global context.

Besides attention on ‘B’ plan institute has given considerable importance to the major faults of current Technical Education while framing the syllabus. The major stumbling blocks in Technical Education today are:

I. The present system is producing “Academic Engineers” rather than “Practical Engineers”.
II. The present system of education makes the students to run after jobs rather than making them competent to create jobs.
III. There is lack of initiative to implement the reality of “Imagination is more important than knowledge”.

Taking due consideration of the findings made above, to my mind credible syllabi has been framed in the institute in which the major innovations are introduction of:
I. I-Course (Industrial Course) one in each semester at least one, which is targeted to be taught by the Industrial Expert at least up to 50% of its component.

II. Man making and service to society oriented compulsory credit courses of NCC/NSS, values & ethics.

III. Compulsory audit course on Entrepreneurship for all branches.

IV. Many add-on courses that are (non-credit courses) to be offered in vacation to enhance the employability of the students.

V. Many audit courses like French, German, and Chinese to enhance the communication skill in global scale for the students.

VI. Research and imagination building courses such as Research Paper Communication.

VII. Design Course as “Creative Design”.

Further, the syllabi are framed not to fit in a given structure as we believe structure is for syllabus and syllabus is not for structure. Therefore, as per requirement of the courses, the structure, the credit and the contact hours have been made available in case to case.

The syllabus is also innovative as it includes:

I. In addition to the list of text and reference books, a list of journals and magazines for giving students a flexibility of open learning.

II. System of examination in each course is conventional examination, open book examination and online examination.

Each course has been framed with definite objectives and learning outcomes. The Syllabus has also identified the courses to be taught either of two models of teaching:

I. J. C. Bose model of teaching where practice is the first theory.

II. S. N. Bose model of teaching where theory is the first practice.

Besides the National Institute of Technology, Arunachal Pradesh has initiated a scheme of simple and best teaching in which for example:

I. Instead of teaching RL, RC and RLC circuit separately, only RLC circuit will be taught and with given conditions on RLC circuits, RL and RC circuits will be derived and left to the students as interest building exercise.

II. Instead of teaching separately High Pass Filter, Band Pass Filter and Low Pass Filter etc.; one circuit will be taught to derive out other circuits, on conditions by the students.

I am firmly confident that the framed syllabus will result in incredible achievements, accelerated growth and pretty emphatic win over any other systems and therefore my students will not run after jobs rather jobs will run after them.

For the framing of this excellent piece of syllabus, I like to congratulate all members of faculty, Deans and HODs in no other terms but “Sabash!”.

Prof. Dr. C.T. Bhunia
Director, NIT, (A.P.)
TEACHING GUIDELINES

In order to achieve the desired goal of excellence and innovations in each and every function of National Institute of Technology, Arunachal Pradesh and to implement ‘B’ Plan in totality, I call upon my distinguished members of Faculty to invest some of their valuable business time in doing Research on Teaching. In this context, I put forward the following general guidelines for teaching practices in the institute:

1) **J.C. Bose Model of Teaching:** As an example, in the Basic Electronics course instead of first teaching the colour codes of the resistors in a theoretical class, teacher may carry few resistors to class and note down on the blackboard the colours of resistors and their values. Thereafter, the teacher may ask the students to device the color code creating enthusiasm among students. Similarly, instead of teaching the characteristics of PN junction diode, teacher may guide the students in a laboratory to draw the characteristics curve, then may advise the students to analyse the behaviour of characteristics. Thereafter, the teacher may teach the theory of PN junction diode.

2) **S.N. Bose Model of Teaching:** This is the conventional model of teaching where theory is first practice but even then I suggest some unique ideas to improve imaginative power and creativity of students in the subject. For example, instead of teaching two algorithms for conversion of decimal to binary, one for integral part and another for fractional part, I call upon the teachers to design a single algorithm for both the purposes for inspiring teaching.

3) I also believe that noble teaching will be simple and in simpler way. Therefore, I call upon the teachers not to teach band-pass filter, low pass filter, high pass filter separately. Teachers may design a single circuit for all filters and put on condition thereon can derive separately circuits for separate filters. Similarly, instead of teaching RL, RC and RLC circuits separately, I call upon the teachers to teach only RLC circuit and then putting suitable condition on RLC circuit; RL and RC circuits may be derived and taught.

4) **Last but not the least,** I call upon the teachers to solve all the problems of all chapters of the main text book prescribed for a subject in a teaching-learning process – 50% to be solved by teachers (may be of even ones) and 50% may be solved by students (may be odd ones).

I solicit and anticipate full cooperation from all my brilliant pool of young and energetic faculty members to practice the noble and novel teaching procedures explained above without fail. Once procedures implemented by teachers are documented, we may proceed to file a patent on Research in Teaching on behalf of NIT, Arunachal Pradesh.

Prof. Dr. C.T. Bhunia
Director, NIT, (A.P.)
Mechanical Engineering is one of the major engineering divisions. Its principles are involved in the design, development and construction of nearly all of the physical devices and systems that modern technology has produced. Mechanical engineers are also concerned with the operations of all kinds of machineries, and the production of power. They must conceive research, design, develop, test, manufacture and sell equipment for these purposes. It is one of the oldest and broadest engineering disciplines.

The Department of Mechanical Engineering at National Institute of Technology, Arunachal Pradesh was established in August 2013. The department offers four year degree B.Tech in Mechanical Engineering with an annual intake of 30 students. Within a very short period this Department already developed some New Laboratories with modern art of facilities. A continuous effort is always on towards setting up new laboratories and improvement of facilities in the existing laboratories.

Our objective is to provide students with a quality mechanical engineering education, enhance the understanding and application of mechanical engineering principles, imparting knowledge with imagination for techno economical development of the country, and improving the quality of life of our citizens through teaching, research, and innovation. The mission is further to provide an environment where students will get extensive avenues to excel, improve technical exposure and develop personality and then get recruited in reputed organizations with global presence, in various roles and responsibilities and also to meet the mission of Arunachal Pradesh, North East region and the nation at large.
## Summary Table of Different Courses

<table>
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<tr>
<th>Semester</th>
<th>Credit Course</th>
<th>I- Course</th>
<th>Audit Course</th>
<th>Add-on course</th>
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| 1<sup>st</sup> | Engineering Mathematics I  
Engineering Chemistry  
Engineering Physics I  
Life Science  
Engineering Mechanics  
Engineering Drawing  
Workshop Practice I  
Basic Electrical & Electronics Engineering  
Communication Skill | NIL | NSS/ NCC Foreign Language (French/ Korean) | NIL |
| 2<sup>nd</sup> | Engineering Mathematics II  
Engineering Physics II  
Environmental Science  
Basic Mechanical Engineering Programming in C  
Workshop Practice II  
Digital Electronics & Logic Design  
Historiography of Science & Technology  
Basic Civil Engineering | NIL | Foreign Language (German/ Chinese) | NIL |
| 3<sup>rd</sup> | Engineering Mathematics III  
Basic Thermodynamics  
Material Sciences & Engineering  
Strength of Materials  
Workshop Practice III  
Behavioural Science | Fluid Mechanics I | NIL | NIL |
| 4<sup>th</sup> | Stochastic Processes  
Applied Thermodynamics  
Fluid Mechanics II  
Electrical machines  
Machine Drawing  
Theory of Machines | Engineering Materials and Processes | NIL | Auto CAD/ CAM |
| 5<sup>th</sup> | Machine Design I  
Heat Transfer  
Measurement and Metrology  
Manufacturing Technology  
Industrial Engineering & Management | Internal Combustion Engines | NIL | ANSYS/ PRO E |
| 6<sup>th</sup> | Engineering Ethics & IPR  
Disaster Management  
Dynamics of Machinery  
Machine Design II  
Automation and Computerized Manufacturing  
Numerical Methods in | Power Plant Engineering  
Automation and Computerized | NIL | MATLAB+LABVIEW/ C++ |
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<th>Manufacturing</th>
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<td>Refrigeration and Air-Conditioning</td>
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<td>Seminar &amp; Group Discussion</td>
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<td>Industrial Training</td>
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## Examination System

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| 1<sup>st</sup> | Engineering Chemistry  
Life Science  
Engineering Mechanics  
Engineering Drawing I  
Workshop Practice I  
Communication Skill  
NSS/ NCC  
Foreign Language (French/ Korean) | Engineering Mathematics I  
Engineering Physics I  
Basic Electrical & Electronics Engineering | NIL |
| 2<sup>nd</sup> | Engineering Mathematics II  
Basic Mechanical Engineering  
Workshop Practice II  
Basic Civil Engineering  
Environmental Science  
Engineering Physics II  
Digital Electronics & Logic Design  
Historiography of Science & Technology  
Foreign Language (German/ Chinese) | Programming in C | NIL |
| 3<sup>rd</sup> | Engineering Mathematics III  
Basic Thermodynamics  
Material Sciences & Engineering  
Fluid Mechanics I  
Workshop Practice III  
Behavioural Science | Strength of Materials | NIL |
| 4<sup>th</sup> | Stochastic Processes  
Applied Thermodynamics  
Engineering Materials and Processes  
Fluid Mechanics II  
Machine Drawing  
Entrepreneurship and Innovation | Theory of Machines | NIL |
| 5<sup>th</sup> | Internal Combustion Engines  
Heat Transfer  
Measurement and Metrology  
Manufacturing Technology  
Industrial Engineering & Management  
Electrical Machines | Machine Design I | NIL |
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<tr>
<th>Semester</th>
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<td>Project, Thesis &amp; Viva&lt;br&gt;Grand Viva&lt;br&gt;Seminar and Group Discussion&lt;br&gt;Industrial Training</td>
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# INDEX

## FIRST SEMESTER

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### SEVENTH SEMESTER

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SEMESTER-I
(Common to all Branches)

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Contact Hrs: 39; Credit: 29

**Name of the Module: Engineering Mathematics I**
**Module Code: MAS 101**
**Semester: 1st**
**Credit Value: 4 [P=0, T=1, L=3]**

**A. Objectives:**
The course is designed to meet with the following objectives:

1. Providing high quality education in pure and applied mathematics in order to prepare students for graduate studies or professional careers in mathematical sciences and related fields.
2. Imparting theoretical knowledge and to develop computing skill to the students in the area of Science and Technology.
3. Providing teaching and learning to make the students competent to their calculating ability, logical ability and decision making ability.
4. Giving students theoretical knowledge of Calculus, Algebra and their practical applications in the various fields of Science and Engineering.
5. Apply their knowledge in modern industry or teaching, or secure acceptance in high-quality graduate programs in Mathematics and other fields such as the field of quantitative/Mathematical finance, Mathematical computing, statistics and actuarial science.

**B. Learning Outcomes:**
Students successfully completing this module will be able to:

1. Become more confident about their computing skill, logical skill and decision making skill.
2. Find various applications of Calculus and Algebra in the practical field’s science and engineering.
3. Become more competent to analyse mathematical and statistical problems, precisely define the key terms, and draw clear and reasonable conclusions.
4. Use mathematical and statistical techniques to solve well defined problems and present their mathematical work, both in oral and written format, to various audiences (students, mathematicians, and non-mathematicians).

5. Understand, and construct correct mathematical and statistical proofs and use the library and electronic data-bases to locate information on mathematical problems.

6. Explain the importance of Mathematics and its techniques to solve real life problems and provide the limitations of such techniques and the validity of the results.

7. Propose new mathematical and statistical questions and suggest possible software packages and/or computer programming to find solutions to these questions.

C. Subject Matter:
Unit I:
Matrices: Introduction to Matrices and their basic properties, Transpose of a matrix, verification of the properties of transposes, Symmetric and Skew symmetric matrices and their properties. Determinant of a square matrix, Minors and Cofactors, Laplace’s method of expansion of a determinant, Product of determinants, Adjoint of a determinant, Jacobi’s theorem on adjoint determinant. Singular and non-Singular matrices, Adjoint of a matrix, Inverse of a non-singular matrix and its properties, Orthogonal matrix and its properties, Trace of a matrix, Rank of a matrix and its determination using elementary row and column operations, Solution of simultaneous linear equations by matrix inversion method, Consistency and inconsistency of a system of homogeneous and non homogeneous linear simultaneous equations, Eigen values and Eigen vectors of a square matrix (of order 2 or 3), Eigen values, Cayley-Hamilton theorem and its applications, Diagonalisation of a square matrix with real and distinct eigen values (up to 3rd order).

Unit II:
Successive Differentiation: Higher order derivatives of a function of single variable, Leibnitz’s theorem (statement only) and its application, problems of the type of recurrence relations in derivatives of different orders.
Mean Value Theorems & Expansion of Functions: Rolle’s theorem (statement only) and its application, Mean Value theorems – Lagrange & Cauchy (statement only) and their application, Taylor’s theorem with Lagrange’s and Cauchy’s form of remainders (statement only) and its application, Expansions of functions by Taylor’s and Maclaurin’s theorem, Maclaurin’s infinite series expansion of the functions.

Unit III:
Integrals: Double and triple integrals and evaluation of area and volume. Change of order of integration.
Reduction formula: Reduction formulae both for indefinite and definite integrals.

Unit IV:
Complex variables: complex numbers, De-Moivre’s Theorem and its applications, Inverse circular and Hyperbolic functions, functions, continuity, Differentiability, analyticity -Cauchy Riemann equations and properties of analytic functions, Cauchy's integral and Cauchy's integral formula, derivatives of analytic functions.

D. Teaching/ Learning/ Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

E. Examination Pattern:
   Theoretical Examination: Written

F. Reading Lists:
Books:

Magazines:
1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of Sheffield).
5. +Plus magazine (University of Cambridge).

Journals:
3. The Journal of Indian academy of Sciences.

Name of the Module: Engineering Chemistry
Module Code: CHY 101
Semester: 1st
Credit Value: 4 [P=2, T=0, L=3]

A. Objectives:
The course is designed to meet with the following objectives:
   1. Imparting theoretical and practical knowledge to the students in the area of Chemistry.
2. Providing teaching and learning to make students acquainting with advanced science and technology in Chemistry.
3. Injecting the future scope and the research direction in the discipline of Chemistry.
4. Making students competent to the research and development in advanced science and technology in Chemistry.

B. Learning outcomes:
Students successfully completing this module will be able to:
1. Adequately trained to become Chemists, Scientist and Chemical Engineers.
2. Skilled both theoretically and practically to do operation, control and maintenance works in Chemistry and Chemical Engineering.
3. Substantially prepared to take up prospective research assignments.

C. Subject matter:
Unit I:

**Chemical Thermodynamics:** Concept of Thermodynamic System: diathermal wall, adiabatic wall, isolated system, closed system, open system, extensive property, intensive property. Introduction to first law of thermodynamics: different statements, mathematical form; internal energy: physical significance, mathematical expression (ideal and real gas), Enthalpy: physical significance, mathematical expression. Cp and CV definition and relation; adiabatic changes; reversible and irreversible processes; application of first law of thermodynamics to chemical processes: exothermic, endothermic processes, law of Lavoisier and Laplace, Hess's law of constant heat summation, Kirchoff's law. Second law thermodynamics; Joule Thomson and throttling processes; inversion temperature; evaluation of entropy: characteristics and expression, entropy change in irreversible process, entropy change for irreversible isothermal expression of an ideal gas, entropy change of a mixture of gases.

Work function and free energy: physical significance, mathematical expression for ideal and real gases obeying Vander Waals' equation, Gibbs Helmholtz equation. Condition of spontaneity and equilibrium

Unit II:

**Electrochemistry Conductance:** Conductance of electrolytic solutions, specific conductance, equivalent conductance, molar conductance and ion conductance, effect of temperature and concentration, Kohlrausch’s law of independent migration of ions, transport numbers and hydration of ions, Conductometric titrations: SA vs SB & SA vs WB, precipitation titration KCl vs AgNO3.

**Electrochemical cell:** Cell EMF and its Thermodynamic significance, single electrode potentials and its applications; hydrogen half cell, quinhydrone half cell and calomel half cell. Storage cell, fuel cell. Application of EMF measurement, Reaction Dynamics: Reaction laws: rate and order; molecularity; zero, first and second order kinetics, Arrhenius equation, Mechanism and theories of reaction rates (Transition state theory, Collision theory). Catalysis: Homogeneous catalysis and heterogeneous catalysis.

Unit III:

**Structure and reactivity of Organic molecule:** Electro negativity, electron affinity, hybridization, Inductive effect, resonance, hyper conjugation, electromeric effect, carbocation, carbuniom and free radicals. Brief study of substitution, eliminations and addition reactions, **Instrumental Methods of Analysis:** Introduction to instrumental methods such as IR, UV, VIS, NMR and Mass spectrometry.

Unit IV:

**Polymerization:** Concepts, classifications and industrial applications, Polymerization processes (addition and condensation polymerization), degree of polymerization, Co-polymerization, stereo-regularity of polymer, crystallinity and amorphicity of polymer, Preparation, structure and use of some
common polymers: plastic (PE, PP, PVC, bakelite), rubber (natural rubber, SBR, NBR), fibre (nylon 6.6, polyester), Conducting and semi-conducting polymers.


**D. List of practicals: (Minimum eight experiments should be conducted by students)**
1. Acid base titration : (Estimation of commercial caustic soda)
2. Red-ox titration: (Estimation of iron using permanganometry)
3. Complexometric titration: (Estimation of hardness of water using EDTA titration)
4. Chemical Kinetics : (Determination of relative rates of reaction of iodide with hydrogen peroxide at room temperature (clock reaction).
5. Heterogeneous equilibrium (Determination of partition coefficient of acetic acid between n-butanol and water)
6. Viscosity of solutions (determination of percentage composition of sugar solution from viscosity)
7. Conductometric titration for
   (a) Determination of the strength of a given HCl solution by titration against a standard NaOH solution.
   (b) Analysis of a mixture of strong and weak acid by strong base.
8. Preparation of a homo-polymer by free radical initiated chain polymerization and determination of its molecular weight by viscosity average molecular weight method.
9. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH.

**E. Teaching/ Learning/ Practice pattern:**
- Teaching: 40%
- Learning: 10%
- Practice: 50%

**F. Examination pattern:**
1. Theoretical Examination: Written.
2. Practical Examination: Conduct Practical Examination and viva-voce.

**G. Reading lists:**
**Books:**
3. Levine ” Physical Chemistry” McGraw-Hill Education.
15. Maity and Maity, ” Engineering Chemistry”, U & N Dhar Publisher.

Magazine:
2. Chemistry Today.
3. Chemistry For You.

Journals:
2. Journal of Physical Chemistry, ACS.

Name of the Module: Engineering Physics I  
Module Code: PHY 101  
Semester: 1st  
Credit Value: 4 [P=2, T=0, L=3]

A. Objectives:
The course is designed to meet with the following objectives:
1. Imparting theoretical & practical knowledge to the students in the area of Engineering Physics.
2. Providing teaching and learning to make students acquainting with modern state-of-art of Engineering.
3. Injecting the future scope and the research direction in the field of Physics with specific specialization.
4. Making students competent to design & development of Engineering Physics.

B. Learning outcomes:
Students successfully completing this module will be able to:
1. Adequately trained to become Engineers.
2. Substantially prepared to take up prospective research assignments.

C. Subject matter:
Unit I:
Scalar and vector: Scalar and vector, dot and cross product, Scalar and vector fields, concept of Gradient, Divergence and Curl.
General Properties of Matter: Elasticity, Viscosity, Surface tension.

Unit II:
Acoustics: Simple Harmonic Motion, Damped Vibration, Forced Vibration.

Unit III:
Physical Optics: Introduction to Interference, Diffraction, Polarization.
Elementary Solid State Physics: Elementary ideas of crystal structure: lattice, basis, UNIT cell, fundamental types of lattices-Bravis lattice, simple cubic, f.c.c and b.c.c lattices, Miller indices and miller planes, Co-ordination number and atomic packing factor, X-rays: Origin of characteristics and continuous X-ray, Bragg’s law (no derivation), determination of lattice constant.

Unit IV:
Fundamental of Quantum Physics: Wave particle duality, Compton effect, Photo electric effect, Heisenberg’s uncertainty relation, concept of wave packet.

D. List of practicals: (Minimum five experiments should be conducted by students)
1. Determination of thermal conductivity of a good conductor by searle's method.
2. Determination of thermal conductivity of a bad conductor by Lees and Chorlton's method.
3. Determination the dispersive power of the material of a given prism.
4. Use of carry Foster's bridge to determine unknown resistance.
5. Determination of Young Modulus by flexure method and calculation of bending moment and shear force at a point on the beam.

E. Teaching/ Learning/ Practice pattern:
Teaching: 40%
Learning: 10%
Practice: 50%

F. Examination pattern:
1. Theoretical Examination: Written.
2. Practical Examination: Conduct Practical Examination and viva-voce.

G. Reading lists:
Books:

Magazine:
1. Physics Reports.
2. Quarterly Reviews of Biophysics.
3. Resonance.
5. Scientific Physics.
7. Physics for You.

Journals:
1. Nature
2. Physical Review Letter
3. Physical Review A & B
5. Proceedings of the National Academy of Sciences
6. Chemical Physics Letters
8. Indian Journal of Engineering & Material Sciences

Name of the Module: Life Science
Module Code: BIO 101
Semester: 1st
Credit Value: 3 [P=0, T=0, L=3]

A. Objectives:
The course is designed to meet with the following objectives:
1. Imparting knowledge on the origin of Earth and life forms on Earth, appreciating the importance of biological diversity and understanding bio molecules being the main component of life.
2. Understanding “Cell” the basic unit in different life forms, and structure and function of different tissue systems in plants and animals.
3. Imparting knowledge on water relations, nutrient uptake and assimilation, and metabolism in plants.
4. Providing knowledge on Bioenergetics of plant and animal cells, different organelles involved in electron transport systems, nervous, digestive and immune systems in animals.

B. Learning Outcomes:
Upon completion of the subject, students will be able to:
1. Understand the characteristics of living organisms; appreciate the importance of diversity of life and their interaction with the environment.
2. Explain the interrelationship between bio molecules and the living system, and influences of bio-molecules upon the structure and function of intracellular components.
3. Have a broad knowledge on Bioenergetics of plant and animal cells; and a brief on important biological systems of animal.
C. Subject Matter:

Unit I:
- **Origin of Life:** History of earth, theories of origin of life and nature of the earliest organisms.
- **Varieties of Life:** Classification, Five kingdoms, viruses (TMV, HIV, Bacteriophage), Prokaryote (Bacteria-cell structure, nutrition, reproduction), Protista, Fungi, Plantae and Animalia.
- **Chemicals of Life:** (Bio molecules) Carbohydrates lipids, amino acids, proteins, nucleic acids and identification of bio molecules in tissues.

Unit II:
- **Cell:** Cell concept, structure of prokaryotic and eukaryotic cells, plant cells and animal cells, cell membranes, cellorganelles and their function, Structure and use of compound microscope.
- **Histology:** Maritimess (apical, intercalary, lateral) and their function; simple tissue (parenchyma, collenchymas, sclerenchyma); Complex tissue (xylem and phloem); Tissue systems (epidermal, ground, vascular); primary body and growth (root, stem, leaf); Secondary growth (root, stem), Animal tissues (Epithelial, connective, muscle and nervous tissues) and their functions in the body.

Unit III:
- **Transport:** Plant water relationships, properties of water, diffusion, osmosis, imbibition, uptake of water by roots and theories of transport of water through xylem (ascent of water in xylem, cohesion-tension theory), apoplast and symplast theory; Transpiration-structure of leaf, opening and closing mechanisms of stomata, factors affecting transpiration and significance of transpiration.
- **Nutrition:** Mineral Nutrition in plants, Heterotrophic nutrition in plants; Photosynthesis (Autotrophic-forms of nutrition), Chloroplast structure, two pigment systems, photosynthetic UNIT, light absorption by chlorophyll and transfer of energy, phosphorylation and electron transport system, Calvin-Benson Cycle (C₃), Hatch Slack Pathway (C₄), Crassulacan Acid Metabolism (CAM), factors affecting photosynthesis.

Unit IV:
- **Energy Utilization:** (Respiration) - Structure of mitochondria, cellular respiration, relationship of carbohydrate metabolism to other compounds, Glycolysis, fermentation, formation of acetyl co-A, Kreb cycle, Electron Transport System and Oxidative Phosphorylation, ATP, factors affecting respiration; Elementary canal in humans, nervous and hormonal control of digestive systems, fate of absorbed food materials; Nutrition in humans, Reference values; General characteristics of blood vascular system, development of blood systems in animals, Composition of blood, circulation in blood vessels, formation of tissue fluids, the heart, functions of mammalian blood, the immune system.

D. Teaching/ Learning/ Practice Pattern:
- Teaching: 70%
- Learning: 30%
- Practice: 0%

E. Examination Pattern:
- 1. Theoretical Examination: Written

F. Reading List:
Books:

Magazines:
1. National Geographic Channel

Journals:
3. Plant and Cell Physiology, Oxford Journals, USA.

Name of the Module: Engineering Drawing I
Module Code: CE 101
Semester: 1st
Credit Value: 2 [P=3, T=0, L=0]

A. Objectives:
The course is design to meet with the following objectives:
1. Increase ability to understand Engineering Drawing.
2. Learn to sketch and take field dimensions.
3. Learn to take data and transform it into graphic drawings.
4. Learn basic Auto Cad skills.
5. Learn basic engineering drawing formats.
6. Prepare the student for future Engineering positions.

B. Learning Outcome:
Upon completion of the subject student’s ability to:
1. Hand letter will improve.
2. Perform basic sketching techniques will improve.
3. Draw orthographic projections and sections will improve.
4. Use architectural and engineering scales will increase.
5. Produce engineered drawings will improve.
6. Convert sketches to engineered drawings will increase.
7. Cope up and become familiar with office practice and standards will increase.
8. Handle and become familiar with Auto Cad two dimensional drawings will improve.
9. Develop good communication skills and team work will improve.

C. Subject Matter:
Unit I:
Indian Standards: Line symbols and line groups, sheet layout of rules of printing, preferred scales.

Unit II:

Unit III:
First and third angle system of projection: Technical sketching, Multi-planar representation.

Unit IV:
Glass box concept: Sketching of orthographic views and line.
D. List of Practical:
1. Technical writing of various types of letters.
2. Technical sketching of Scales- Plain, Diagonal, Vanier, Comparative and chord.
3. Technical sketching of Projection of points.
4. Technical sketching of Projection of lines.
5. Technical sketching of Projection of plains.

E. Teaching/ Learning/ Practice Pattern:
  Teaching: 70%
  Learning: 30%
  Practice: 0%

F. Examination Pattern:
  1. Practical Drawing.
  2. Assignment.

G. Reading List:
Books:

Magazine:
2. Design to Part Magazine.

Journals:
Name of the Module: Engineering Mechanics
Module Code: ME 101
Semester: 1st
Credit Value: 3 \([P=0, L=3, T=0]\)

A. Objectives:
The course is designed to meet with the following objectives:
1. Ability to utilise scalar and vector analytical techniques for analysing forces in statically determinate structures.
2. Ability to apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
3. Student gets a basic idea of Centre of gravity, moment of inertia, mass moment of inertia, friction.

B. Learning Outcome:
Upon completion of the subject, students should have the knowledge of:
1. Different type of forces and how to resolve forces.
2. Centre of gravity of different size, shape, and solid.
3. Centre of gravity, moment of inertia, mass moment of inertia, friction.

C. Subject Matter:
Unit I:
**Forces and Moments:** Force, Moment and Couple, Resultant of forces, Forces in space Equilibrium, FBD, General equations of equilibrium, Analysis of forces in perfect frames, Brief introduction to vector approach.

Unit II:
**Friction:** Introduction to dry friction, laws of friction, friction of simple machines, inclined planes, Screw jacks.

Unit III:
**Centre of gravity and moment of inertia:** Centre of gravity of axes, volume and composite bodies, Area moment of inertia and mass moment of inertia for plane figures and bodies.

Unit IV:
**Dynamics:** Kinematics and Kinetics, Rectilinear motion of particles, determination of position velocity and acceleration under uniform rectilinear motion (uniform and non-uniform accelerated rectilinear motion), Relative motion, construction of \(x-t\), \(v-t\) and \(a-t\) graphs (simple problems), Projectile motion, Normal and Tangential components, Radial and Transverse components, simple problems, Equation of motion, D. Alembert’s principle.
D. List of Practical’s: No Practical’s

E. Teaching/ Learning/ Practice pattern:
   Teaching: 60%
   Learning: 40%
   Practice: 0%

F. Examination pattern:
   1. Theoretical Examination.

G. Reading lists:
   Books:
   3. Timoshenko,” Engineering Mechanics “, MGH.

Magazines:
   2. Engineering Magazine.

Journals:
   2. Journal of Applied Mechanics, ASME.

Name of the Module: Workshop Practice I
Module Code: ME 102
Semester: 1st
Credit Value: 2 [P=3, T=0, L=0]

A. Objectives:
The course is designed to meet the following objectives:
   1. Acquire skills in basic engineering practice.
   2. Identify the hand tools and instruments.
   3. Acquire measuring skills.
   4. Acquire practical skills in the trades.
   5. Acquire practical skills in welding, carpentry, fitting.

B. Learning Outcome:
Upon completion of the subject, students should have the knowledge of:
   1. Workshop safety.
2. Handling workshop tools, machines.
3. Different welding types.
4. Different carpentry joints.
5. Working principle of different tools.

C. Subject Matter:

Unit I:
**Carpentry (Wood Working):** Timber, Seasoning and Preservation, Plywood and Ply boards, Carpentry Tools, Engineering applications, Different Joints.

Unit II:
**Metal Joining:** Definitions of welding, brazing and soldering processes and their applications, Oxy acetylene gas welding process, equipment and techniques, types of flames and their applications, Manual metal arc welding technique and equipment, AC and DC welding, electrodes, constituents and functions of electrodes, welding positions, types of weld joint, common welding defects such as cracks, slag inclusion and porosity.

Unit III:
**Bench work and Fitting:** Tools for laying out, chisels, files, hammers, hand hacksaw, their specifications and uses.

Unit IV:
**Laying out (bench work):** Sawing and finishing by filing.

D. List of Practical:
1. T-Lap joints and Bridle joint (Carpentry Shop).
2. Gas Welding practice on mild steel flat/sheet up to 3 mm thick.
3. Lap joint by Gas Welding (up to 3mm thick).
4. Manual Metal Arc Welding practice (up to 5mm thick).
5. Pattern Making (Carpentry Shop).
6. Laying out (bench work), Sawing and finishing by filing.

E. Teaching/Learning/Practice Pattern:
- Teaching: 20%
- Learning: 20%
- Practice: 60%

F. Examination Pattern:
1. Job making.
2. Viva-voce.

G. Reading List:
**Books:**
Magazines:
1. International Metal Working News.
2. Industrial Distribution.

Journals:
2. Journal of Manufacturing Science and Engineering, ASME.

Name of the Module: Basic Electrical & Electronics Engineering

Module Code: EE 101
Semester: 1st
Credit Value: 4 [P=2, T=0, L=3]

A. Objectives:
The course is designed to meet with the following objectives:
1. To make the students familiar with the course and its importance.
2. Introduction to Basic Electrical & Electronics Engineering.
3. Basic knowledge of DC circuits, Electromagnetism, AC fundamental.
4. Introduction to DC, AC single and three phase machine, their construction and working principles.
5. Introduction to measurement of electrical quantities.
7. Briefing to Semiconductor devices and their applications.

B. Learning outcomes:
Students successfully completing this module will be able to:
1. Develop interest in learning the subject and be adequately trained to solve network problems.
2. Skilled both theoretically and practically to utilize conventional circuit solving procedures.
3. Substantially prepared to take up prospective design assignments.

C. Subject matter:
Unit I:
**DC circuits:** Definition of electric circuit, network, linear circuit, non-linear circuit, bilateral circuit, unilateral circuit, Dependent source, Kirchhoff’s law, Principle of superposition. Source equivalence and conversion, Thevenin’s theorem, Norton Theorem, nodal analysis, mesh analysis, star-delta conversion. Maximum power transfer theorem with proof.
**Electromagnetism:** Biot-savart law, Ampere’s circuital law, field calculation using Biot-savart & ampere’s circuital law. Magnetic circuits, Analogous quantities in magnetic and electric circuits, Faraday’s law, self and mutual inductance. Energy stored in a magnetic field, B-H curve, Hysteric and Eddy current losses, lifting power of Electromagnet.

Unit II:
**Decision making:** Simple if statement, if-else statement, nested if else statement, Switch statement, nested switch, the operator, goto statement.
**Decision making & branching:** while statement, do-while statement, for statement. Array

Unit III:
**Transformers:** Construction, Types, emf equation, voltage, current, impedance and turns ratio, auto-transformer, DC machines (motor and generator)—Construction, types, emf equation,
equivalent circuit, starting, speed control, braking, applications. Single phase motors, types; need of rotating field, starting, running, speed control and applications.

**Unit IV:**

**P-N Junction:** Energy band diagram, Formation of P-N junction, built-in-potential forward and reverse biased P-N junction, formation of depletion zone, V-I characteristics, Zener breakdown, Avalanche breakdown and its reverse characteristics, junction capacitance and varactor diode. Simple diode circuits, load line, linear piecewise model; rectifiers: half wave, full wave, its PIV, DC voltage and current, ripple factor, efficiency, Clipper & Clamper Circuits.

**Introduction to Transistors:** Formation of PNP/ NPN junctions, energy band diagram; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off active and saturation mode, early effect. Introduction to Field Effect Transistor: Structure and characteristics of JFET and MOSFET, depletion and enhancement type, CS, CG, CD configurations.

**D. List of practicals: (Minimum eight experiments should be conducted by students)**

1. To construct a series-parallel circuits and verify:  
   - Ohms law, Kirchhoff’s laws  
   - Verify Thevenin’s theorem  
   - Verify Norton’s theorem  
   - Verify Maximum Power Transfer theorem.
2. Construct an R-L-C circuit and verify  
   - Voltage across R, L and C  
   - Verify the phasor sum of the voltages across the combination of R-L-C.
3. Measurement of power in the circuit made in 2 above and verify:  
   - The power consumed by Resistance, Inductance and Capacitance and the total power consumed by the circuit.
4. How does the power factor varies in the circuit of 2 above if Resistance, Inductance and Capacitance are varied.
5. Study of VI Characteristics of Silicon Diode.
7. Design and Analysis of a Half wave Rectifier using Diode.
8. Design and Analysis of a center-tap Full wave Rectifier using Diodes
9. Design and Analysis of a Bridge Rectifier Circuit.
10. Design and Analysis of a Clipping Circuit with one voltage source. (Different possible configurations)
11. Design and Analysis of a Clipping Circuit with two voltage source. (Different possible configurations)
12. Design and Analysis of a Clamper Circuit.
13. Analysis of the characteristics of BJT (CE and CB mode)
14. Design and Analysis of fixed bias circuit using NPN transistor (DC)
15. Design and Analysis of emitter bias circuit using NPN transistor (DC)
16. Determination of the characteristics of JFET.
17. Determination of the characteristics of MOSFET.
18. Verification of truth tables of logic gates.

**E. Teaching/ Learning/ Practice pattern:**

- Teaching: 40%
- Learning: 10%
Practice: 50%

F. Examination pattern:
   1. Theoretical Examination: Written.
   2. Practical Examination: Conduct Practical Examination and viva-voce.

G. Reading lists:
Books:

Magazines:
   1. IEEE Industrial Electronics
   2. Electrical Line, Canada.

Journals:
   1. Electrical Engineering, Springer.

Name of the Module: Communication Skill
Module Code: HSS 101
Semester: 1st
Credit Value: 1 [P=2, T=0, L=0]

A. Objectives:
The course is design to meet with the following objectives:
   1. To increase the Students ability to improve and utilize the skills necessary to be competent interpersonal communicator.
   2. To Increase the student’s understands of his or her own communication behaviour.
   3. To Increase the students understands of others communication behaviours.
   4. To improve the students communication skills of both social professional contexts.
   5. To improve the students ability to demonstrate effective complete resolution skills.

B. Learning Outcomes:
Students successfully completing this module will be able to:
   1. Develop their communication skills on the specific subject.
   2. Learn communication skills and will be able to direct effectively in their world place.

C. Subject Matter:
Unit I:
General Principles of Communication and Oral Communication: The Process of Communication, Principles of Communication (communication barriers, levels of Communication, Communication network, verbal, non-verbal) and Professional Communication. The Speech Mechanism, IPA symbols (vowel and consonant sounds), minimal pairs, word transcription, stress and intonation, active listening, types of listening, traits of a good listener, active versus passive listening.

Unit II:
Constituents of Effective Writing and Vocabulary: The sentence and its parts, articles, the verb phrase, tense and aspect, the active and passive, the adjective, interrogative and negative sentences, concord, preposition. Paragraph development, summary writing and reading comprehension, Word formation processes: affixation, compounding, converting, use of words in different parts of speech, idioms and phrases.

Unit III:

D. List of Practical:
1. Issue Writing
2. Writing Resumes and Applications
3. Writing Memos
4. Reading Comprehension
5. Vocabulary
6. Presentation Skills
7. Group Discussion
8. Extempore
9. Debates

E. Teaching/ Learning/ Practice Pattern:
  Teaching: 40%
  Learning: 10%
  Practice: 50%

F. Examination Pattern:
  1. Theoretical Examination

G. Reading List:
Books:
1. Nira Konar, “English Language Laboratory”, Prentice Hall India
5. Rajeevan, Dutt, Sasikumar, A course in Listening and Speaking I & II with CD, CUP, New Delhi, 2007.
7. Software: Orell Digital Language Lab Software.
10. Krishna Mohan and MeeraBannerji ,Development Communication Skills
Magazines:
1. Communication Skill Magazine
2. Magazine for Communication
3. Communication Studies

Journals:
1. Developing Effective Communication Skills.
2. Cooperative Communication Skills.
3. Improving Communication Skills.
5. Journal on Communication.

Name of the Module: Foreign Language (French) (Audit)
Module Code: HSS 103
Semester: 1st
Credit Value: 0[P=2, T=0, L=0]

A. objectives:
The course is design to meet with the following objectives:
1. The French Language course accords to a method created for Indian students who are complete beginners in French and who wish to acquire verbal communication skills in current scenario.

B. Learning outcome:
Students successfully completing this module will be able to:
1. Develop four skills in French i.e. Reading, Writing, Speaking, Comprehension.

C. Subject matter:
Unit I:
Preliminaries of Grammar: Articles, Gender and Number of Nouns and Adjectives, Personal and Tonique Pronouns, Demonstrative and Possessive Adjectives, Preposition and Adverbs.

Unit II
Conjunction: Pronominal Verbs Conjugation of Verbs of all the Groups in present Tense and Introduction to past and Future tense, Interrogation, Negation and Imperatives.

Unit III
Name of days, seasons, Months, colours, garments body parts and numbers, Computer, Commerce & Marketing related Vocabulary & Terminology, Phonetics and Pronunciation.

D. List of Practical:
1. Issue Writing
2. Writing Resumes and Applications
3. Writing Memos
4. Reading Comprehension
5. Vocabulary
6. Presentation Skills
7. Group Discussion
8. Extempore
9. Debates

E. Teaching/ Learning/ Practice Pattern:
   Teaching: 40%
   Learning: 10%
   Practice: 50%

F. Examination Pattern:
   1. Theoretical Examination

G. Reading List:
   Books:
Semester- II
(Common to all Branches)

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Contact Hrs: 39; Credit: 29

Name of the Module: Engineering Mathematics II
Module Code: MAS 201
Semester: 2nd
Credit Value: 4 [P=0, T=1, L=3]

A. Objectives:
The course is design to meet with the following objectives:
1. Imparting theoretical knowledge to the students about three and more dimensional objects in space and to improve their capability of visualising of objects in space.
2. Making student competent enough to construct a differential equation/ mathematical modelling for every real life situation with its solution.
3. Giving students theoretical knowledge of vectors with the flavour of Calculus.
4. Introduce the concepts of Laplace and Fourier transforms and its application to the solution of differential equations (ODE & PDE) to the students.

B. Learning Outcomes:
Upon completion of the subject, students will:
1. Have strong visualising capability in their mind about any object.
2. Be so trained that they will recognize various real life situation/ problem and able to solve them by
constructing a differential equation/mathematical model.

3. Be able to find the Laplace and Fourier representation as well as transforms of functions of one variable.

C. Subject Matter:
Unit I:
Coordinate Geometry Of Three Dimensions: Equation of a sphere, plane section of a sphere, tangent plane, orthogonality of spheres, definition and equation of right circular cone and right circular cylinder.

Unit II:
Vector Calculus: Differentiation and integration of vector functions, scalar and vector fields, Gradient, Directional derivative, Divergence, Curl, Line integral, Surface integral and Volume integral, Green’s, Gauss’ and Stokes’ theorems (without proofs) and their simple applications.

Unit III:
Ordinary Differential Equations: Formulation of Differential equations, Linear Differential Equations and reducible to linear form, Exact Equations, Reducible to exact form, Linear differential equations with constant coefficients, Second order ordinary differential equations with variable coefficients, Homogeneous form, Change of dependent variable, Change of independent variable, Normal form, Variation of Parameters, Solution in series of second order LDE with variable coefficient (C.F. only), Bessel’s and Legendre differential equations with their series solutions, Orthogonal properties, recurrence relations and generating function of Bessel functions and Legendre polynomials.


Unit IV:
Basic Transform: Laplace & Fourier.

D: Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%

E: Examination Pattern:
1. Theoretical Examination and open book examination.

F: Reading Lists:
Books:

Magazines:
1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Indian Mathematical Society).
3. Mathematical Spectrum (The University of Sheffield).
5. +Plus magazine (University of Cambridge).

Journals:
3. The Journal of Indian academy of Sciences.

Name of the Module: Basic Mechanical Engineering
Module Code: ME 201
Semester: 2nd
Credit Value: 3 [P=0, T=0, L=3]

A. Objectives:
The course is design to meet with the following objectives:
  1. Ability to utilise scalar and vector analytical techniques for analysing forces in statically
determinate structures.
  2. Ability to apply fundamental concepts of kinematics and kinetics of particles to the analysis of
simple, practical problems.
  3. Student gets a basic idea of Engineering Mechanics, Fluid Mechanics, Strength of Material and
Thermodynamics.

B. Learning Outcome:
Upon completion of the subject, students will have the:
  1. Knowledge of different type of force resolving.
  2. Knowledge of centre of gravity of different size, shape, and solid.
  3. Knowledge of basic idea of Engineering Mechanics, Fluid Mechanics, Strength of Material and
Thermodynamics.

C. Subject Matter:
Unit I:
Thermodynamics: Introduction to Thermodynamics, Concepts of system control volume, state, properties, equilibrium, quasi-static process, reversible & irreversible process, cycle. Zeroth Law and Temperature, Heat and Work transfer Definition, Sign convention, various P-dV work done (Isobaric, Isochoric, Polytrophic, adiabatic and isothermal processes) and related problems.

Unit II:

Unit III:
Fluid Mechanics: Properties & Classification of Fluids – ideal & real fluids, Newton’s law of viscosity, Newtonian & Non Newtonian Fluids, Compressible & Incompressible fluids Pressure at a point, Pascal’s law, Measurement of Pressure, Continuity equation, Bernoulli’s equation and its application

Unit IV:
Strength Of Materials: Concept of simple stresses and strains. Yield strength, Normal stress Shear stress, Bearing stress, Normal strain, Shearing strain, Hooke’s law, poisson’s ratio, Examples.

D. List of Practical: No practicals.

E. Teaching/Learning/Practice Pattern:
Teaching: 60 %
Learning: 40 %
Practice: 0%

F. Examination Pattern:
1. Theoretical Examination.

G. Reading List:
Books:
3. Timoshanko & Young, “Elements of Strength of Materials” D Van Nostrand Company

Magazine:
1. PopularMechanics Everyday
2. Engineering Magazine

Journals:
1. International Journal of Applied Mechanics and Engineering
2. Journal of Applied Mechanics, ASME

Name of the Module: Programming in C
Module Code: CSE 201
Semester: 2nd
Credit Value: 4 [P=8, T=0, L=0]

A. Objectives:
The course is designed to meet with the following objectives:
1. Introducing art, science and engineering of C programming language to the students of all UG programs.
2. Teaching and training of different problems in data structures.
3. Guiding and training students to write efficient coding.
4. Guiding & training students to fragment problems into different functions or units.

B. Learning outcomes:
Students successfully completing this module will be able to:
1. Understand the basic terminology used in computer programming.
2. Write, compile and debug programs in C language in different operating systems.
3. Design programs involving decision structures, loops and functions.
4. Use and apply the dynamics of memory by the use of pointers in engineering applications.
5. Use and apply the differences between structure oriented and function oriented programming in programming applications.

C. Subject matter:
Unit I:
Basic concept: Some basic concept of binary number, Octal number, hexadecimal number system and their conversion among them, Assembly language, high level language, Compiler and assembler (basic concept).
Keyword & Identifiers: History & Importance of C, Basic structure of C programs, C fundamentals: The C character set identifier, Constants and keywords, data types & size, variable names, declaration, statement, C token, symbolic constant.
Managing Input & output operations: using of printf( ) & scanf( ).

Unit II:
Decision making: Simple If statement, if-else statement, nested if else statement, Switch statement, nested switch, the operator, goto statement.
Decision making & branching: while statement, do-while statement, for statement. Array

Unit III:
Functions: Basic functions, function type, function with no argument & no return value, function with no argument but return value, function with argument & return value, Storage class identifier, Call by reference, Recursive function, Pointer to function.

Unit IV:
Structure & Union: Defining a structure, accessing of structure variable, structure and array, array within structure, Nested structure, structure & functions, Pointer & structure, Unions.
File management system: Advantage of using files, Open, close, read, write in the files, Operation on files.
Dynamic memory Allocation: use of Malloc, calloc, realloc, free. Library functions, Linked list concept.

The pre-processor: macro statements.

D. List of practicals: (Minimum eight experiments should be conducted by students)

1. Write a program to find the highest number of a given set of numbers and print the numbers of the set in descending order. [Minimum size of set=50]
2. Write a program to list even numbers and odd numbers separately in ascending order of a given set of minimum size of 50.
3. Write a program to find roots of a given quadratic equation.
4. Write a program to test whether a given number is prime or not.
5. Write a program to check whether a given number is a palindrome or not (For Eg. 121->121).
6. Write a program to compute the following series and test it for different inputs.
   a) \(2 + 4 + 6 + 8 \ldots \ldots \ldots\)
   b) \(f(x) = 1! + 2! + 3! + 4! + \ldots \ldots\)
   c) \(f(x) = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots \ldots\)
   d) \(f(x) = 1 + x + x^2 + x^3 + x^4 + \ldots \ldots\)
7. Write a program to display the following patterns using nested for loops.
   a) *
   b) ###
   c) 1 0 1
   d) *
   e) A B C D C B A
   f) *

8. Write a C program to find the maximum element from given input array elements.
9. Write a C program to sort an array elements using BUBBLE sort.
10. Implement the C program for the following numbering system conversion:
    1. Decimal to Binary and Vice-versa (By a single algorithm both for integer and fractional part).
    2. Octal to Binary and Vice-versa.
    3. Hexadecimal to Binary and Vice-versa.
11. Write a program to add two given matrices each of size (nXm).
12. Write a program to multiply any two given matrices.
13. Write a program to check whether a given matrix is Identity matrix or not.
14. Write a program to generate calendar of a given year & print both in desk and wall mode.
15. Write a program to implement factorial of a given input using recursive function.
16. Write a program to differentiate between call by value and call by reference.
17. Write a program to pass an array to a function and find minimum value of it.
18. Write a program to explain scope, visibility and the lifetime of variables.
19. Write a program to explain reference variable and its implementation.
20. Write a program to swap two values using pointer and function.
21. Write a mini project to store all records of students and search by their name, roll number or registration number.
22. Write a program the explain the concept of pointer to a structure..
23. Write a program to differentiate between Enumerated data types, Union and Structures.
24. Write a program to create, edit, open, delete a file and perform different operations accordingly.
25. Write a program to backup one file to another file.
26. Write a program to merge two files.
27. Write a mini project to control mouse cursor and display whether left, right or scroll happens.

E. Teaching/ Learning/ Practice pattern:
   Teaching: 40%
   Learning: 10%
   Practice: 50%

F. Examination pattern:
   1. Theoretical Examination: Open book and on line.
   2. Practical Examination: Conduct Programming test and viva voice.

G. Reading lists:
Books:

Magazines:
1. C/C++ Users, CMP Media LLC publication, United States.
2. EPS Software Corp/CODE Magazine, 6605 Cypresswood Drive, Suite 300 Spring, TX 77379.

Journals:
3. Dr. Dobb's Journal, United Business Media publication, United State, ISSN: 1044-789X
4. Journal of C Language, CMP Media LLC publication, United States
5. C vu Journal, ACCU, UK.

Name of the Module: Environmental Science
Module Code: CHY 201
Semester: 2\textsuperscript{nd}
Credit Value: 3 \{P=0, T=0, L=3\}

A. Objectives:
The course is designed to meet with the following objectives:

1. Imparting the knowledge to the students in the area of Environmental Engineering.
2. Providing teaching and learning to make students acquainting with advanced science and technology in Environmental Science.
3. Injecting the future scope and the research direction in the discipline of Environmental Engineering.
4. Making students competent to the research and development in Environmental Engineering.

B. Learning outcomes:
Students successfully completing this module will be able to:

1. Adequately train them to become Scientist, trainers and Chemical Engineers.
2. Be skilled both to control and maintenance in Environmental pollution, waste water treatment and other related activities in Environmental Engineering.
3. Substantially prepared to take up prospective research assignments.

C. Subjects Matters:

Unit I:


Unit II:

Unit III:

Unit IV:
Air quality standards, emission standards, criteria pollutants, air pollution and meteorology, atmospheric dispersion, emission controls, Air pollution and pollutants, criteria pollutants, Acid deposition, Global climate change – greenhouse gases, non-criteria pollutants, air pollution meteorology, Atmospheric dispersion, Industrial Air Emission Control, Flue gas desulfurization, NOx removal, Fugitive emissions.

D. Reading List:

Books:
2. Arcadio P. Sincero & Gregoria A. Sincero, "Environmental Engineering" Prentice Hall India
4. Curringham & Saigo, “Environmental Science”, TMH,
6. Gilbert M Masters, " Introduction to Environmental Engineering and Science” Prentice Hall

Magazines:
1. Applied Environmental Research Foundation
2. Environmental Science and Engineering
3. Climate Wire
4. Down to Earth
5. The Green Economist
6. Green Wire

Journals:
1. Journal of Environmental Science, Elsevier Publication
2. Environmental Science and Technology, ACS Publication
3. Energy and Environmental Science, RSC Publication
4. Environmental International, Elsevier Publication

Name of the Module: Engineering Physics II
Module Code: PHY 201
Semester: 2nd
Credit Value: 4 [P=2, T=0, L=3]

A. Objectives:
The course is designed to meet with the following objectives:
1. Imparting theoretical & practical knowledge to the students in the area of Engineering Physics.
2. Providing teaching and learning to make students acquainting with modern state-of-art of Engineering.
3. Injecting the future scope and the research direction in the field of Physics with specific specialization.
4. Making students competent to design & development of Engineering Physics.

B. Learning Outcomes:
Students successfully completing this module will be able to:
1. Adequately trained to become Engineers.
2. Substantially prepared to take up prospective research assignments. Students will be substantially prepared to take up prospective research assignments.

C. Subject Matter:
Unit I:
Electricity: Coulombs law in vector form, Electrostatic field and its curl, Gauss's law in integral form and conversion to differential form, Electrostatic potential and field, Poisson’s Eqn., Laplace's Eqn. (Application to Cartesian, Spherically and Cylindrically symmetric systems-effective 1D problems) Electric current, drift velocity, current density, continuity equation, steady state current Dielectrics concept of polarization.

Unit II:
Magnetostatics & time varying Field: Lorentz force, force on a small current element placed in a magnetic field, Biot-Savart law and its applications, divergence of a magnetic field, vector potential, ampere's law in integral form and conversion to differential form, Faraday's law of electromagnetic induction in integral form and conversion to differential form.

Electromagnetic theory: conception of displacement current, Maxwell’s field equations, Maxwell's wave equation and its solution for free space, E.M wave in a charge free conducting media, skin depth, physical significance of skin depth, E.M. energy flow & pointing vector.

Unit III:
Quantum Mechanics: Wave particle duality, Compton effect, Photo electric effect, Black body radiation, Heisenberg’s uncertainty relation, concept of wave packet. Conception of probability and probability density, operators, commutator, Formulation of quantum mechanics and basic postulates, Time dependent Schrodinger's equation, Formulation of Time independent Schrodinger's equation, physical interpretation of wave function, Free particle and particle in a box.

Unit IV:
Statistical Mechanics: Concept of energy levels and energy states, Microstates, macrostates and thermodynamic probability, equilibrium macrostate, MB, FD, BE statistics (No deduction necessary), fermions, bosons (definitions in terms of spin, examples), physical significance and application, classical limits of quantum statistics Fermi distribution at zero & non-zero temperature, Bose-Einstein statistics – Planck’s law of blackbody radiation.

D. List of practicals: (Minimum six experiments are required to be performed)
1. Determination of dielectric constant of a given dielectric material.
2. Determination of resistance of ballistic galvanometer by half deflection method and study of variation of logarithmic decrement with series resistance.
3. Determination of specific charge (e/m) of electron by J.J. Thomson’s method.
4. Determination of Planck’s constant using photocell.
5. Determination of Rydberg constant by studying Hydrogen/ Helium spectrum.
6. Determination of Stefan’s radiation constant.
7. Verification of Bohr’s atomic orbital theory through Frank-Hertz experiment.
8. Determination of Hall co-efficient of semiconductors.
9. Determination of band gap of semiconductors
10. Use of carry Foster’s bridge to determine unknown resistance

E. Teaching/ Learning/ Practice Pattern:

   Teaching: 40%
   Learning: 10%
   Practice: 50%

F. Examination Pattern:

   1. Theoretical Examination: Open book and line.
   2. Practical Examination: Conducting Experiment and Viva-Voce.

G. Reading lists:

Books:

8. S. N. Ghoshal, “Atomic Physics” S. Chand
10. A. B. Gupta, “Modern Atomic and Nuclear Physics” BOOKS and Allied (P) Ltd.

Magazine:

1. Resonance
2. American Teacher
3. Scientific Physics
Journals:
1. Nature
2. Physical Review Letter
3. Physical Review A & B
5. Proceedings of the National Academy of Sciences
6. Chemical Physics Letters
7. Journal of Physics: (Including A, B, C, D, E, F & G)
8. Journal of Scientific & Industrial Research
9. Indian Journal of Engineering & Material Sciences
10. Indian Journal of Radio and Space Physics

Name of the Module: Digital Electronics & Logic Design
Module Code: ECE 201
Semester: 2nd
Credit Value: 4 [P=2, T=0, L=3]

A. Objectives:
The course is designed to meet with the following objectives:
1. To make the students to build a solid foundation about Boolean algebra.
2. To make the students to study Digital Logic Gates and Circuits.
3. To provide a clear foundation of Modern Digital System.

B. Learning outcomes:
At the end of this module, students are expected to be able to
1. Clear understanding & utilization of logic gates
2. Design and develop of advanced TTL logic circuits
3. Utilization of Combinational and Sequential circuits, Counters, ADC and DAC

C. Subject matter:
Unit I:
Number Systems: Decimal, Binary, Octal and Hexadecimal systems, conversion of a number from one base to another.
Codes: BCD, Excess- 3, Gray, Reflected, ASCII, EBCDIC.
Algebra for logic circuits: Logic variables; Logic constants; Logic functions- NOT, AND, OR, NAND, NOR, Ex-OR;
Combinational circuits: Full Adder / Subtractor, BCD Adder, LAC Adder, Comparator, Decoder, Encoder, Priority Encoder, MUX/DEMUX & there structures, Combinational logic design using ROM array, Applications of MSI designs.

Unit II:
Minimization Techniques & System Design: Basic models of sequential M/C, Analysis of Asynchronous and Synchronous circuits, Synthesis of completely and incompletely specified synchronous sequential M/Cs, Combination & Sequential Circuits. Boolean Algebra (including Shannon's expansion theorem and consensus theorem); Ven diagram representation, Canonical representations-min-term, max-term; Karnaugh map simplification, Quine Mcclusky minimization, Minimization of Multiple Input and multiple Output system, Introduction to state machines, Classification of State Machines, State Machine Applications, Analysis of State Machine, State table, State Diagram, State Equation, State reduction and State assignment.

Unit III:
Other Gates & Circuits: Difference between combinational and sequential circuits, Sequential Gates: Triggering of sequential logic circuits. Difference between flip flop and latch Construction of RS, D, JK, JK master slave, T flip flops using basic gates, preset and clear signal, Shift Registers: Serial in serial out – Serial in parallel out, Parallel in serial out, Parallel in parallel out, Universal Shift Registers & their Applications, Counters: Asynchronous and synchronous counter, Ripple counter, Mod-N counter, Up-down counter, Ring counter, Johnson counter, Programmable counter – Applications, Design of Synchronous State Machine (including Counter) and Asynchronous state machine.

Unit IV:
Logic Families: Comparative studies of different type of logic families like RTL, Diode logic, DTL, TTL, III, HTL, ECL, MOS & CMOS etc. with the following characteristics: (a) logic levels, (b) power dissipation, (c) fan in and fan out, (d) propagation delay, and, (e) noise immunity, Data Converters: Digital to Analog Converters: Binary weighted resistor type, R-2R ladder type, Specifications and applications of DA converter. Analog to Digital Converter: Comparator type, Successive approximation type, Dual slope AD converter, Specifications and applications of AD converter.

D. List of Experiments: (Minimum eight experiments should be conducted by students)

1. Study Data Hand Book and list at least 5 chips for each of primary, secondary gates & flip-flops and draw their diagram with pin configuration.
2. Verify Truth Table of NOT, 2-input AND and 2-input OR gate thereby inference.
   i) Single line definition of multiple input AND & OR gate.
   ii) What is the primary difference between NOT gate from AND & OR gate.
3. Study the Truth Table of the following by circuits.

   ![Diagram](image_url)
ii) Compare the Truth Table of i) & ii) and that of AND gate and state inference.

4. Design Gray to Binary and Binary to Gray Converter & test
5. Design and test byte operated even parity generator & then convert it to odd parity generator.
6. Design and test (7,4) Hamming Code Generator and Error Correction decoder.
7. Design a Majority Gate and use it & a XOR gate to realize Adder Circuit & Verify.
8. With Serial Data input design a single circuit for test of >,<and =for two data.
9. Minimize the following logic system with SOP by tabular technique & implement the circuit.
   i) \[ f_1(A,B,C,D) = m_0 + m_1 + m_2 + m_3 + m_5 + m_6 + m_{10} + m_{13} + m_{15} \]
   ii) \[ f_2(A,B,C,D) = m_0 + m_1 + m_2 + m_3 + m_7 + m_{10} + m_{13} \]
   iii) \[ f_3(A,B,C,D) = m_1 + m_2 + m_3 + m_5 + m_6 + m_7 \]
10. Minimize the following logic circuit defined in POS by tabular minimization technique:
    i) \[ f_4(X,Y,Z) = M_0.M_1.M_3.M_7 \]
    ii) \[ f_5(X,Y,Z) = M_0.M_1.M_2.M_6.M_7 \]
11. Write a C programmed to implement Tabular Technique for minimization of system as in problem (8)& (9)
12. Test Truth Table of
    i) S – R flip flop
    ii) J – K flip flop
    iii) D – flip flop
    iv) T – flip flop
13. Design 1 bit Read/Write memory with flip-flop and other logic gate & test.
15. Design a binary counter & test.
16. Design one ADC & one DAC circuit & test.

E. Teaching/Learning/Practice Pattern:
   Teaching: 40%
   Learning: 10%
   Practice: 50%

F. Examination Pattern:
   1. Theoretical Examination: Open book/ Regular examination and on line test.
   2. Practical Examination: Conducting Experiment and Viva-Voice.

G. Reading List:
   Books:

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Magazines:

Journals:
1. International Journal of Electronics Devices and Circuits.

Name of the Module: Historiography of Science & Technology
Module Code: HSS 201
Semester: 2nd
Credit Value: 3[P=0, T=0, L=3]

A. Objectives:
The course is design to meet with the following objectives:
1. Providing teaching with inclusive learning.
2. Imparting theoretical lectures with case discussion.
3. Making students aware about the importance of this subject in their future career.

B. Learning Outcomes:
Students successfully completing this module will be able to:
1. Work with efficiency as they had knowledge of the subject.
2. Perform much better in their workplace.

C. Subject Matter:
Unit I:

Introduction: An overview: definitions, Different approaches to the scientific explorations, to introduce humanity’s endeavour behind science and its application over the centuries, characteristics of history of science and technology.

Unit II:

Motivation: Nature of drives, needs and motives, work motives, need of hierarchy theory and two factor theory of motivation, How to motivate the workers at work, factors effecting the morale of workers.

Lives of Eminent Scientists: To understand the Background, Opportunities, Achievements and Qualities in their efforts to become Scientist of first order.
Scientific Eras: Course of Civilization and Scientific Endeavour.

Contribution of science: Contribution to the present day World.

Unit III:

Answers to the Criticism that Science has created a World full of Pollutions.

D. Teaching/Learning/Practice Pattern:

Teaching: 40%
Learning: 10%
Practice: 50%

E. Examination Pattern:

1. Theoretical Examination: Open book/ Regular examination and on line test.

F. Reading List:

Books:


Magazine:

1. Science and Technology Magazine
2. Historiography of Contemporary Science and Technology

Journal:

1. Historiography in Graduate Technology
2. Innovation, Technology or History
3. Historiography of the Sciences

Name of the Module: Basic Civil Engineering

Module Code: CE 202

Semester: 2nd

Credit Value: 22 [P=3, T=0, L=0]

A. Objectives:

The course is design to meet with the following objectives:

1. Increase ability to understand Engineering Drawing.
2. Learn to sketch and take field dimensions.
3. Learn to take data and transform it into graphic drawings.
4. Learn basic engineering drawing formats.
5. Prepare the student for future Engineering positions.
B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Perform basic sketching techniques will improve.
2. Able to draw orthographic projections and sections.
3. Use architectural and engineering scales will increase.
4. Produce engineered drawings will improve
5. Convert sketches to engineered drawings will increase.

C. Subject Matter:
Unit I: Traditional Materials: stones, bricks, lime, cement, timber. Mortar: sand, cement mortar, mud mortar, special mortar and test on mortar Concrete: plain concrete, reinforced cement concrete, reinforced brick concrete

Unit II: Metals as Building materials: Ferrous metals, aluminum, copper. Miscellaneous Building materials: Glass, plastics, bitumen, asbestos, paints, distempers, varnishes, solid and hollow concrete Blocks, Roofing and flooring tile

Unit III: Superstructures: Types of superstructure based on the method of load transfer, walls, stone masonry, brick masonry, plastering, pointing, flooring, roof, doors and lintels, stairs.

Unit IV: Surveying: Introduction to surveying-Object and uses of surveying, primary divisions of surveying, fundamental principles of surveying, classification of surveying, plans and maps, scales.

D. Teaching/Learning/Practice Pattern:
Teaching: 40%
Learning: 10%
Practice: 50%

E. Examination Pattern:
1. Theoretical Examination: Open book/ Regular examination and on line test.

F. Reading List:
Books:
2. Ramamurtham, “Basic Civil Engineering”, Dhanpat Rai and sons
3. S S Bhavikatti “Basic Civil Engineering” New Age international Publishers,

Magazine:
1. Civil Engineering and Construction Review.

Journals:
Name of the Module: Workshop Practice II
Module Code: ME 202
Semester: 2nd
Credit Value: 2 [P=3, T=0, L=0]

A. Objectives:
The course is designed to meet with the following objectives:
1. To acquire skills in basic engineering practice.
2. To identify the hand tools and instruments.
3. To acquire measuring skills.
4. To acquire practical skills in the trades.
5. To acquire practical skills in welding, carpentry, fitting.

B. Learning Outcome:
Upon completion of the subject, students will have knowledge of:
1. Workshop safety.
2. Handling workshop tools, machines.
3. Different welding types.
4. Different carpentry joints.
5. Different tools working principle.

C. Subject Matter:
Unit I:
Bench work and Fitting: Tools for laying out, chisels, files, hammers, hand hacksaw, their specifications and uses, plumbing, Sheet metal Work.

Unit II:
Metal Joining: Definitions of welding, brazing and soldering processes, and their applications, Oxy acetylene gas welding process, equipment and techniques, Types of flames and their applications, Manual metal arc welding technique and equipment, AC and DC welding, electrodes, constituents and functions of electrodes, Welding positions, Types of weld joint, Common welding defects such as cracks, slag inclusion and porosity.

Unit III:
Machine Shop: Introduction, Basic Principles of Lathe, Shaper, Milling, Drilling, Grinding, Power Hacksaw, etc.

D. List of Practicals:
1. To practice Gas welding using a 3mm thick mild steel plate. (Welding Shop)
2. To prepare a Lap joint and Butt joint by Gas Welding from 3mm thick mild steel plate (Welding Shop).
3. To practice Manual metal arc welding using a 5mm thick mild steel plate (Welding Shop).
4. To prepare various patterns using wood as a pattern material with the help of specific tools. (Carpentry Shop)

5. To perform various bench working operations like sawing, filling and finishing on a 5mm thick mild steel plate using specific tools (Fitting Shop).

6. To prepare jobs (Square, Angular and Semi Circular grooves) using 5mm mild steel plate using specific tools (Fitting Shop)

7. T-Lap joint and Bridle joint (Carpentry Shop).

8. Gas Welding practice on mild steel flat/sheet upto 3 mm thick.

9. Lap joint by Gas Welding (upto 3mm thick).

10. Manual Metal Arc Welding practice (upto 5mm thick).

11. Pattern Making. (Carpentry Shop)

12. Laying out (bench work); Sawing and Finishing by Filing.

E. Teaching/Learning/Practice Pattern:
   Teaching: 20%
   Learning: 20%
   Practice: 60%

F. Examination Pattern:
   1. Job making.
   2. Viva-voce.

G. Reading List:
   Books:
   5. Hazra and choudhary “Workshop Technology” Vol. 1, 2, Media Promoters

Magazines:
   1. International Metal Working News.
   2. Industrial Distribution

Journals:
   1. International Journal of Machine Tools and Manufacture
   2. Journal of Manufacturing Science and Engineering, Transactions of the ASME
   3. Journal of Manufacturing Technology and Research
Name of the Module: Foreign Language (German/Chinese) (Audit)
Module Code: HSS 202
SEMESTER: 2nd
Credit Value: 2 [P=2, T=0, L=0]

A. Objectives:
The course is designed to meet the following objectives:
1. The French Language course accords to a method created for Indian students who are complete beginners in French and who wish to acquire verbal communication skills in current scenario.

B. Learning outcome:
Students successfully completing this module will be able to:
1. Develop four skills in French i.e. Reading, Writing, Speaking, Comprehension.

C. Subject matter:
Unit-I:
Self Introduction, Introducing Friends, Family & person’s Topical writing, Essays Description of Persons Place, Things, Class, City, Country, House, Plan a Week-End, Excursion,

Unit-II:
Making Resume, Interviews Letter Writing, Rejecting or accepting proposals, Invitation, Dialogues, Tastes & Preferences.

Unit-III:
Conversational French between Known & Unknown people, Telephonic Conversation with Friends & Client

D. List of Practical:
1. Issue Writing
2. Writing Resumes and Applications
3. Writing Memos
4. Reading Comprehension
5. Vocabulary
6. Presentation Skills
7. Group Discussion
8. Extempore
9. Debates

E. Teaching/ Learning/ Practice Pattern:
   Teaching: 40%
   Learning: 10%
   Practice: 50%

F. Examination Pattern:
1. Theoretical Examination

G. Reading List:
Books:
1. *Suggested book-Ailes Volume-II*
Semester - III

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Contact Hrs: 31; Credit: 27

Name of the Module: Mathematics III
Module Code: MAS 311
Semester: 3rd
Credit Value: 4 [P=0, T=1, L=3]
Module Leader:

A. Objectives:
The course is designed to meet the following objectives:
1. To study and develop the functions of one complex variable.
2. To perform a thorough investigation of the major theorems of complex analysis: the Cauchy-Riemann Equations, Cauchy’s Theorem, Cauchy’s Integral Formula, the Maximum Modulus Principle, Liouville’s Theorem, the Residue Theorem, Rouche’s Theorem, the Riemann Mapping Theorem including their proofs.
3. Apply these ideas to a wide range of problems that include the evaluation of both complex line integrals and real integrals.

B. Learning Outcomes:
Upon completion of the subject, students should understand:
1. How complex numbers provide a satisfying extension of the real numbers.
2. How throwing problems into a more general context may enlighten one about a specific context.
3. The techniques of complex analysis that make practical problems easy.
4. And continue to develop proof techniques.

C. Subject Matter:
Unit I:

Unit II:
Line Integrates: Canchy-Gourset theorem (no proof required), Cancly’s Integral formula, Derivative of analytic functions, Taylor’s and Laurent’s series, Zeroes, Singular points, essential and removable, Poles, Residue, Residue Theorem, Contour Integration (simple cases only).

Unit III:
Vector and Euclidean spaces: Linea dependence, Bases, Vector space and subspaces, Point sets, Convex sets, Boundary Points, Extreme points, Linear system – Basic Solutions, Basic matrix, Feasible solution, Basic feasible solution.

Unit IV:
Boundary value and Initial value problems leading to partial differential Equation: Method of solution by separation of variables Technique.

D. Teaching/ Learning/ Practice Pattern:
Teaching: 70%  
Learning: 30%  
Practice: 0%

E. Examination Pattern:
1. Theoretical Examination.

F. Reading List:
Books:
1. C. L. Liu, “Elements of Discrete Mathematics”, MGH.  

Magazines:
1. Current Science (Indian Academy of Science).  
2. The Mathematics Student (Math Student) (Indian Mathematical Society).  
3. Mathematical Spectrum (The University of Sheffield).  
5. Plus magazine (University of Cambridge).  

Journals:
1. SIAM Journal on Discrete Mathematics.  
Name of the Module: Basic Thermodynamics
Module Code: ME 301
Semester: 3rd
Credit Value: 5\([P=2, L=3, T=1]\)
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. Understand basic definitions and terminology.
2. Identify special definitions from the thermodynamics point of view.
3. Discover why and how natural processes occur only in one direction unaided.
4. Understand the concept of property and how it defines a state.
5. Identify the change of state results in a process.
6. Determine why processes are required to build cycles.
7. Recognize the differences between work producing and work consuming cycles.
8. Be aware of the coordinates on which the cycles are represented and why.
9. Know how some of the work producing cycle works.
10. Understand why water and steam are special in Thermodynamics.
11. Value the importance of air standard cycles.

B. Learning Outcome:
Upon completion of the subject, the students should have:
1. A fundamental understanding of the first and second laws of thermodynamics and their application to a wide range of systems.
2. Understand the first law of thermodynamics and various forms of work that can occur. An ability to analyse the work and heat interactions associated with a prescribed process path, and to perform a first law analysis of a flow system.
3. The ability to evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations. Familiarity with calculations of the efficiencies of heat engines and other engineering devices.
4. Understand the use of the Gibbs and Helmholtz free energies as equilibrium criteria, and the statement of the equilibrium condition for closed and open systems. An understanding of the interrelationship between thermodynamic functions and an ability to use such relationships to solve practical problems.
5. Familiarity with the construction and principles governing the form of simple and complex one-component pressure-temperature diagrams and the use of volume-temperature and pressure-volume phase diagrams and the steam tables in the analysis of engineering devices and systems.
6. Ability to determine the equilibrium states of a wide range of systems, ranging from mixtures of gases, mixtures of gases and pure condensed phases, and mixtures of gases, liquids, and solids that can each include multiple components.
7. Familiarity with basic concepts in solution thermodynamics, and an ability to relate the characteristics and relative energies of different liquid and solid solutions to the phase diagram of the system.
8. Familiarity with basic concepts in electrochemistry.

C. Subject Matter:
Unit I:


Unit II:
Entropy: Clausius Theorem and Inequality, Entropy Principle, Entropy and Disorder, Evaluation of Entropy changes during various processes, T-s and h-s diagrams, Concept of Third Law of Thermodynamics, Entropy changes for flow process.

Unit III:

Unit IV:
Auxiliary Functions: Availability of Non-Flow as well as Flow Processes, Gibb’s Function, Helmholtz Function, Maxwell Relation, T-ds Equations, Clapeyron Equation, Concept of energy, Joule Kelvin effect, \( C_p \), \( C_v \) relation in terms of P,V, T.

D. List of Practical:
1. Study of various parts of a 4-stroke Petrol Engine along with their significance.
2. Study of various parts of a 2-stroke Petrol Engine along with their significance and compare it with a 4 stroke petrol engine.
3. Study of various parts of a 4-stroke CI engine along with their significance and point out the differences between a SI engine and CI engine.
4. Study of various parts of a Cochran Boiler along with their significance.
5. Study of various parts of a Babcock-Wilcox Boiler along with their significance.
6. Study the use of a Planimeter and also learn to calibrate it.
7. Study the use of a Vacuum gauge and also learn to calibrate it.

E. Teaching/Learning/Practice Pattern:
Teaching: 60 %
Learning: 30 %
Practice: 10%

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:
Name of the Module: Material Sciences & Engineering
Module Code: ME 302
Semester: 3rd
Credit Value: 3 [P=0, T=1, L=3]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:

1. Know the fundamental science and engineering principles relevant to materials.
2. Understand the relationship between nano/microstructure, characterization, properties and processing and design of materials.
3. Have the experimental and computational skills for a professional career or graduate study in materials.
4. Possess knowledge of the significance of research, the value of continued learning and environmental/social issues surrounding materials.
5. Be able to communicate effectively, to work in teams and to assume positions as leaders.

B. Learning Outcome:
Upon completion of the subject, the students should be:
1. Able to apply general math, science and engineering skills to the solution of engineering problems.
2. Aware of the social, safety and environmental consequences of their work, and be able to engage in public debate regarding these issues.
3. Capable to apply core concepts in Materials Science to solve engineering problems.
5. Able to select materials for design and construction.
6. Able to design and conduct experiments, and to analyse data.
7. Able to understand the professional and ethical responsibilities of a materials scientist and engineer.
8. Capable to work both independently and as part of a team.
9. Able to communicate effectively while speaking, employing graphics and writing.
10. Possessing the skills and techniques necessary for modern materials engineering practice.

C. Subject Matter:

Unit I:
Crystal Structure: Unit cells, the face centred cubic crystal structure, the body centred cubic crystal structure, and the hexagonal close packed structure, Crystallographic directions and planes, Determination of crystal structures, Crystal defects.

Unit II:
Mechanical Properties of Metal: Concepts of stress and strain, Tension tests, Compression and Shear tests, Elastic deformation- Stress-Strain behaviour, Plastic deformation, Tensile properties, Yielding and yield strength, Ductility, Toughness, True stress and strain, Elastic recovery during plastic deformation, Creep, Fatigue, Proof stress.

Unit III:
Stability of Phases and Equilibrium: Liquid solid transition, Phase equilibrium diagrams, Cooling curves, The liver rule, Iron-Iron carbide equilibrium diagram, TTT diagram. Crystalization, Nucleation, Homogeneous nucleation, Heterogeneous nucleation, Crystal growth, Full annealing, Spheroidizing, Normalizing, the isothermal transformation diagram, Continuous cooling transformation diagram, Tampering, Hardenability, application of heat treatment for gear, thread etc.

Unit IV:
Cast Iron: Classification of CI, production of various types of cast iron and their applications, brief introduction of alloys, their uses and application, Composite materials, ceramic materials, polymer, and corrosion.

D. Teaching/Learning/Practice Pattern:
Teaching: 60 %
Learning: 40%
Practice: 0%

(Teacher is to divide components for T/R/P)

E. Examination Pattern:
1. Theoretical Examination.

F. Reading List:
Books:
4. Boothroyd, “Fundamental of Metal Machining and Machine tools”, TMGH.
5. P. N. Rao, “Manufacturing Technology (Vol I & II)”, TMGH.

Magazine:
1. Material Today.
2. Discover.

Journals:
3. Applied Materials & Interfaces.

Name of the Module: Strength of Materials
Module Code: ME 303
Semester: 3rd
Credit Value: 5 [P=3, T=0, L=3]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. To establish an understanding of the fundamental concepts of mechanics of deformable solids; including static equilibrium, geometry of deformation, and material constitutive behaviour.
2. To provide students with exposure to the systematic methods for solving engineering problems in solid mechanics.
3. To discuss the basic mechanical principles underlying modern approaches for design of various types of structural members subjected to axial load, torsion, bending, transverse shear, and combined loading.
4. To build the necessary theoretical background for further structural analysis and design courses.

B. Learning Outcome:
Upon completion of the subject, the students should:
1. Have the concepts and principles applied to members under various loadings and the effects of these loadings.
2. Be able to analyse and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behaviour of materials.
3. Be able to analyse columns and pressure vessels under various loadings.
4. Be able to conduct himself or herself professionally and with regard to his or her responsibilities toward society, especially with respect to designing machine parts and structures to prevent failure.
C. Subject Matter:

Unit I:

**Simple stresses and strains:** Stress, strain, types of stresses, elastic limit, Hook’s law, Analysis of bars of varying sections, law of superposition, composite bar, thermal stress, thermal stresses in composite bars, elongation of bar due to its own weight, stress-strain diagram.

**Elastic constants:** Introduction, longitudinal & lateral strain, Poisson’s ratio, volumetric strain for rectangular bar, Bulk Modulus, Principle of complementary shear stress, Relation between various elastic constants.

Unit II:

**Principle stresses and strain:** Introduction, Principle planes and principle stresses, methods for determining stresses on oblique section, Analytical method, Graphical method, Mohr’s circle, use of Mohr’s circle to find Principle stresses.

**Strain Energy and Impact Loading:** Introduction, Resilience, proof resilience, Modulus of Resilience, expression for strain energy stored in a body for different loading conditions and shear stress.

Unit III:

**Shear force and Bending moment:** Introduction, different types of beams and loads, S.F & BM diagram for a cantilever, Uniformly distributed load, Simply supported beam for various types of loading, relation between load, shear force and Bending moment diagram.

**Torsion of shafts:** Introduction, Basic assumptions, Derivation of shear stress produced in a circular shaft subjected to torsion, Maximum torque transmitted by acicular and hollow circular shaft, Polar modulus, strength of a shaft and tensional rigidity, composite shafts, combined bending and torsion, Strength of a shaft of varying cross section, Buckling vertical column, slenderness ratio.

Unit IV:

**Thin and Thick cylinder:** Introduction, Thin cylindrical vessel subjected to internal pressure, expression for circumferential and longitudinal stress in thin cylinder, stresses in thick cylindrical shells, stresses in compound thick cylinder.

D. List of Practical:

1. To determine hardness of material with the help of various methods such as Rockwell, Brinell and Vickers tests.
2. To determine the impact strength of materials with the help of pendulum type impact testing machine.
3. To determine tensile properties of ductile material with the help of Universal testing machine (UTM).
4. To determine the compressive properties of non-ductile materials with the help of UTM.
5. To determine the compressive strength of brittle materials with the help of compressive testing machine.
6. To perform various types of non-destructive tests and thus obtain various properties of materials.
7. To determine the creep and fatigue of a material using Creep testing and Fatigue testing machine.

E. Teaching/Learning/Practice Pattern:

- Teaching: 60%
- Learning: 20%
- Practice: 20%

(Teacher is to divide components for T/R/P)
F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:
Books:

Magazine:
2. Everyday Engineering Magazine.

Journals:
**Name of the Module: Fluid Mechanics I**

**Module Code: ME 304**

**Semester: 3**

**Credit Value: 5 [P=3, T=0, L=3]**

**Module Leader:**

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**A. Objectives:**
The course is designed to meet with the following objectives:

1. Define the nature of a fluid.
2. Show where fluid mechanics concepts are common with those of solid mechanics and indicate some fundamental areas of difference.
3. Introduce viscosity and show what Newtonian and Non-Newtonian fluids are.
4. Define the appropriate physical properties and show how these allow differentiation between solids and fluids as well as between liquids and gases.

**B. Learning Outcome:**
Upon completion of the subject, the students should:

1. Know, understand and apply the basic concepts of Fluid Mechanics to carry out professional engineering activities in the field of fluids.
2. Be able to apply scientific method strategies to fluid mechanics, analyse qualitatively and quantitatively the problem situation, propose hypotheses and solutions.
3. Be able to use specific vocabulary and terminology and the appropriate means to effectively communicate knowledge, procedures, results, skills and aspects inherent to fluid mechanics.
4. Work efficiently in a group, integrating skills and knowledge to make decisions in the performance of fluid mechanics tasks, adopting a responsible and organised attitude to work and a willingness to learn.
5. Be able to plan and carry out designs and processes in the field of fluid mechanics in accordance with the relevant specific technology, applying the quality principles and methods and analysing and assessing the social and environmental impact of the technical solutions adopted.

**C. Subject Matter:**

**Unit I:**

**Properties of fluid:** Mass and weight density, specific gravity, specific volume, viscosity and Newton’s law of viscosity, Compressibility, Types of fluid, surface tension and capillarity.

**Pressure and its measurement:** Fluid pressure at a point and Pascal’s law, absolute, gauge and vacuum pressures, pressure variation in a fluid at rest, pressure measurement, Manometers and Mechanical Gauges.

**Hydrostatics:** Total pressure and centre of pressure for horizontal, vertical, inclined plane surfaces and curved surfaces submerged in liquid, total pressure and centre of pressure on lock gates.

**Buoyancy and flotation:** Buoyancy, centre of buoyancy, metacentre and metacentre height and equilibrium of floating bodies, period of oscillation, Types of fluid flow, streamline with equation, streak line, path line, translation, rotation, deformation, Kinematics of flow, continuity equation in three dimensions, velocity potential function and stream function, forced and free vortex flow.

**Unit II:**

**Dynamics of flow:** Euler’s equation and Bernoulli’s equation, application of Bernoulli’s equation venturi-meter, orifice-meter, and pitot tube.
Orifice and Notches: Flow through orifices, hydraulic coefficients, time of emptying hemispherical and horizontal cylindrical tank through an orifice at its bottom, Discharge over rectangular, triangular and trapezoidal notches, velocity of approach, rectangular, triangular and trapezoidal notches, velocity of approach.

Laminar flow: Flow of viscous fluid through circular pipe-velocity distribution and average velocity, Hagen Poiseuille formula, Kinetic energy correction and Momentum Correction factors, Navier-Stokes equation of motion.

Turbulent Flow: Reynold’s experiment, Loss of head due to friction in pipes, Reynold’s expression and Prandtl mixing length theory for turbulent shear stress.

Unit III:
Flow through Pipes: Major and minor losses of energies in pipes, Hydraulic gradient and total energy lines, flow through pipes in series, equivalent pipe, Flow through parallel pipes, Power transmission through pipes and nozzles, water hammer.

Flow in open channel: Uniform flow through open channels, Chezy’s formula, and most economical sections of channel, Non-uniform flow-specific energy and specific energy curve, critical depth and critical velocity, minimum specific energy, hydraulic jump.

Unit IV:
Dimensional and Model Analysis: Dimensions of fundamental and derived quantities, Dimensional Homogeneity, Rayleigh’s method and Buckingham’s pie-theorem, dimensionless, Model Laws, classification of models.

D. List of Practical:
1. To perform an experiment to verify Bernoulli’s equation and thus explain its use and importance.
2. To determine the co-efficient of friction in pipes.
3. To determine co-efficient of contraction due to sudden contraction in pipes.
4. To determine loss of head due to sudden enlargement in pipes.
5. To determine co-efficient of discharge of venturi-meter.
6. To determine co-efficient of discharge of Orifice-meter.

E. Teaching/Learning/Practice Pattern:
   Teaching: 60 %
   Learning: 20 %
   Practice: 20%

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination
2. Practical Examination

G. Reading List:
Books:
1. F. M. White, “Fluid Mechanics”, TMGH.
8. Streeter and Willy, “Fluid Mechanics”, MGH.

Magazine:
1. Pumps & Systems.
2. World Pumps.
3. Hydraulics & Pneumatics.

Journals:
3. Experiments in Fluids.

Name of the Module: Workshop Practice III
Module Code: ME 351
Semester: 3rd
Credit Value: 2 [P=3, T=0, L=0]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. To acquire skills in basic engineering practice.
2. To identify the hand tools and instruments.
3. To acquire measuring skills.
4. To acquire practical skills in the trades, and
5. To acquire practical skills in welding.

B. Learning Outcome:
Upon completion of the subject, the students should have the knowledge of:
1. Workshop safety.
2. Handling workshop tools, machines.
3. Different welding types.
4. Different carpentry joints, and
5. Different tools working principle.

C. Subject Matter:
Unit I:
Machine Shop: Introduction to the machine tools (lathe, shaper, planer, drilling etc), introduction to cutting tool, and properties of different materials used in cutting tool, Method of metal cutting.

Unit II:
Fitting Shop: Introduction, use of precision tools & jobs, to make a fitting as per drawing.

Unit III:
Sheet Metal Shop: Introduction to sheet metal tools, Sheet metal operation - cutting, notching, soldering and brazing.

Fabrication of: (a) square tin, (b) round tin with lid, (c) “T” pipe joint (d) waste paper basket, (e) measuring jar etc.

Forging Shop: Introduction to tools & equipment, hand forging & machine forging, forging operation, defects in forgings.

Unit IV:
Casting techniques Job: (a) to prepare a sand mould, using the single piece pattern Spilt pattern/ loose piece pattern/pattern with core etc.
Welding Shop: Introduction of welding equipments and safety measures, Different joint of welding & their use, Welding process, Different types of electrode, fluxes & their uses, Practice on setting welding equipment, gas welding & cutting practice, preparation of simple structures Job, different types of welding joint (lap joint, butt joint, single ‘v’ groove joint).

D. List of Practical:
1. To practice Gas Welding on a mild steel sheet 3 mm thick.
2. To prepare a Lap joint by Gas Welding on a 3mm thick mild steel sheet.
3. To practice Manual Metal Arc Welding on a 5mm thick mild steel plate.
4. To practice Tungsten Inert Gas Welding (TIG welding) on a 5mm thick mild steel plate.
5. To practice Metal Inert Gas Welding (MIG welding) on a 5mm thick mild steel plate and differentiate between TIG and MIG welding processes.
6. To prepare a pattern using specific tools and learn Pattern Making process and importance.
7. To prepare a ball peen hammer from a cylindrical workpiece by bench work processes using specific tools (Files, hammer, etc).
8. To perform specific operations like turning, facing, chamfering and knurling on a cylindrical job using Centre Lathe.

E. Teaching/Learning/Practice Pattern:

Teaching: 20 %
Learning: 10 %
Practice: 70 %

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Viva.

G. Reading List:
Books:
8. Boothroyd, “Fundamental of Metal Machining and Machine Tools”, TMGH.

Magazine:
1. International Metal Working News.
2. Industrial Distribution.

Journals:
2. Journal of Manufacturing Science and Engineering, Transactions of the ASME.

Name of the Module: Behavioural Science
Module Code: HSS 301
Semester: 3rd
Credit Value: 2 [P=0, T=0, L=2,]
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:
1. Imparting theoretical lectures with case discussion.
2. Providing teaching with inclusive learning.
3. Making students aware about the importance of this subject in their future career.

B. Learning Outcomes:
Upon completion of the subject, students will be:
1. Able to work with efficiency as they had knowledge of the subject.
2. Able to perform much better in their workplace.

C. Subject Matter:
Unit I:
   Behavioural Science: An overview, definitions, man the critical factor, Behavioural science and its historical development.
   Motivation: Nature of drives, needs and motives, work motives, need hierarchy theory and two factor theory of motivation, how to motivate the workers at work, factors effecting the moral of workers.

Unit II:
Industrial Sociology: Concept and Definitions, importance for Engineers, Growth and Criticism of the Hawaiian Studies, Nature and scope of Industrial sociology, Industry and Community, Industry and Tradition in India.

Society and Technical Change: Concept of social change, meaning and definitions of social change, nature of social change, factors such as Natural, Cultural, Economic, Planning, Technological, Indian Information Technology Scenario, Effect of Technology on Social Institutions.


Unit III:
Groups: Meaning and Definitions, types of Groups, characteristics, functions of formal and informal groups, merits and demerits of in formal groups.

Unit IV:
Human relations: Historical overview, definitions, early and later approaches to human relations, strategies for establishing healthy human relations.
Labour management relations: Industrial relations, meaning, objectives and definitions, Dunlop’s theory of industrial relations, Psychological and Gandhian approach to industrial relations, industrial relations in Japan and India, industrial relation in coming years, challenges of coming years, new dimensions of industrial relations, the ways of industrial peace, Trade unions, meaning and definitions, functions of Indian trade Unions, recent emerging trends in Indian trade unions.

D. Teaching/ Learning Pattern:
Teaching: 50%
Learning/ case presentation: 30%
Assignment: 10%
Attendance: 10%

E. Examination Pattern:
1. Theoretical Examination.
2. Class test.
3. Assignment.

F. Reading List:
Books:

Magazine:
1. Leadership Quarterly.
2. HBR Magazine.
Journal:
2. Behavioural and Brain Sciences.
Semester- IV

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Contact Hrs: 35; Credit: 31

Name of the Module: Stochastic Processes
Module Code: MAS 401
Semester: 4th
Credit Value: 4 \([P=0, L=3, T=1]\)
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:
1. Imparting theoretical knowledge and practical application to the students in the area of Stochastic Processes.
2. Introducing the basic notions of probability theory and develops them to the stage where one can begin to use probabilistic ideas in statistical inference and modeling, and the study of stochastic processes.
3. Providing confidence to students in manipulating and drawing conclusions from data and provide them with a critical framework for evaluating study designs and results.
4. Injecting future scope and the research directions in the field of stochastic process.

B. Learning outcomes:
Upon Completion of the subject, students will be able to:
1. Add new interactive activities to fill gaps that we have identified by analysing student log data and by gathering input from other college professors on where students typically have difficulties.
2. Add new simulation style activities to the course in Inference and Probability.
3. Substantially prepare them to take up prospective research assignments.

C. Subject Matter:
Unit I:
Theory of Probability: Random Experiment, Sample space, Random Events, Probability of events, Axiomatic definition of probability, Frequency Definition of probability, Finite sample spaces and equi-probable measure as special cases, Probability of Non-disjoint events (Theorems), Counting
techniques applied to probability problems, Conditional probability, General Multiplication Theorem, Independent events, Bayes’ theorem and related problems.

Random variables: discrete and continuous, Probability mass function, Probability density function and distribution function.

Distributions: Binomial, Poisson, Uniform, Exponential, Normal, t and $\chi^2$, Expectation and Variance (t and $\chi^2$ excluded), Moment generating function, Reproductive Property of Binomial, Poisson and Normal Distribution (proof not required), Transformation of random variables (One variable), Chebychev inequality (statement) and problems.

Unit II:

Approximation Theory: Binomial approximation to Poisson distribution and Binomial approximation to Normal distribution (statement only), Central Limit Theorem (statement), Law of large numbers (Weak law), Simple applications.

Unit III:

Sampling Theory: Population, Sample, Statistic, Estimation of parameters (consistent and unbiased), Sampling distribution of sample mean and sample variance (proof not required).

Estimation Theory: Point estimate, Maximum likelihood estimate of statistical parameters (Binomial, Poisson and Normal distribution), Interval estimation.

Testing of Hypothesis: Simple and Composite hypothesis, Critical Region, Level of Significance, Type I and Type II Errors, Best Critical Region, Neyman-Pearson Theorem (proof not required), Application to Normal Population, Likelihood Ratio Test (proof not required), Comparison of Binomial Populations, Normal Populations, Testing of Equality of Means, $\chi^2$—Test of Goodness of Fit (application only).

Unit IV:

Correlation and Regression: Simple idea of Bivariate distribution, Correlation and Regression and simple problems.

D. Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

1. Theoretical Examination & Open book examination.

F. Reading list:

Books:


Magazines:
1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of Sheffield).
5. +Plus magazine (University of Cambridge).

Journals:
1. Advances in Probability and Related Topics (Marcel Dekker).
4. Communications on Stochastic Analysis.
18. SANKHA, ISI, Kolkata.
Name of the Module: Electrical Machines.

Module Code: EE 400

Semester: 4th

Credit Value: 5 [P=3, T=0, L=3]

Module Leader:

A. Objectives:
The course is designed to meet the following objectives:

1. To understand the basic principle and operation of rotating electrical machines, their classifications, basic efficiency and performance characteristics.
2. To understand the basic configuration of separately excited permanent magnet, shunt and series DC machines.
3. To analyse DC machine under steady state dynamic operation.
4. To understand the basic configuration of synchronous and asynchronous Machine.

B. Learning Outcome:
Upon completion of the subject, students will be:

1. Made familiar with DC/AC Machines used practically, their operating and control characteristics.
2. Well acquainted with the methods of designing of DC/AC machines and modelling.
3. Substantially prepared to take up prospective research assignments.

C. Subject Matter:
Unit I:

Basic electromagnetic theory.

Single phase transformer: Basic principle of single phase transformer, equivalent, circuit phasor diagram, test regulation and efficiency and loses in transformer, Auto transformer and Welding transformer.

3 phase transformer: Basic principle of 3 phase transformer, parallel connection, principle operation, energy conversion and loses in 3 phase transformer.

Unit II:

DC machines: Basic principle of DC machine, types, winding, generator circuit, armature reaction.

Unit III:

AC machines: Basic principle of synchronous and asynchronous Machine.

Unit IV:

Special Machines: Basic principle, types, performance servo and stepper motor.

D. List of Practical:

1. O.C.C of DC Generator.
2. D.C. Shunt generator build up.
3. Load Test on DC Generator
4. Load Test on DC Motor.
5. Starting, Running and reversing of DC motor.
6. Speed Control of DC motor by field and armature.
8. V-curve of alternator.
E. Teaching/Learning/Practice Pattern:

| Teaching | 60 % |
| Learning | 20% |
| Practice | 20% |

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:
Books:
5. Fitzgerald, Kingsley C.and Umans, S. D. “Electric Machinery”, (5th Ed.), MGH Book Co.92,

Magazine:
1. IEEE Xplore.
2. Electricity Today T & D Magazine.

Journals:
1. The Journal of the Institute of Electrical and Electronics Engineers, Japan.

Name of the Module: Applied Thermodynamics
Module Code: ME401
Semester: 4th
Credit Value: 4 [P=0, T=1, L=3]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. Fundamental understanding of applied thermodynamics in an engineering perspective and how to integrate it with other subjects in engineering practice.
2. Determine the thermodynamic properties of an ideal gas and the pure substances with or without phase change.
3. Recognize the difference between the ideal and real processes and cycles, understand how to apply the first and the second laws to these processes and cycles, and be able to determine the thermal merit of various types of processes and cycles.
4. Formulate the basic models necessary to study, analyze, and design thermal systems and understand the basic methods to increase the thermal efficiency.
5. Formulate and solve problems and to develop communication skills for good engineering practice.
6. Study the subjects for which Thermodynamics is a pre-requisite at later stages.
7. Gain an increased awareness and emphasis on energy resources and environmental issues.

B. Learning Outcome:
Upon completion of the subject, the students should be able to demonstrate:

1. The power cycle analysis using various working fluids.
2. The analysis of refrigeration and heat pump cycles using various working fluids.
3. The construction of thermodynamic property tables and the capability to determine changes in enthalpy, entropy and internal energy using a suitable equation of state.
4. The analysis of thermodynamic systems and cycles and to perform appropriate calculations where ideal gas mixtures are the working fluid.
5. The application of psychometrics to analysis of heating, drying and air conditioning systems.
6. The application of the first and second laws to combustion processes.
7. The thermodynamic analysis of realistic problems using computer software.

C. Subject Matter:
Unit I:
Ideal gas, properties of gases and mixtures of gases, enthalpy change of Ideal gas, specific heat and entropy of gas mixture, Air standard cycles, Otto-cycle, Diesel cycle, Limited pressure cycle, comparison of Otto diesel and dual cycle, Brayton cycle, Stirling cycle and Ericsson Cycle.

Unit II:
Reciprocating air compressor, single and multistage, volumetric efficiency, Maxwell's equation T-ds equation, Joule-Kelvin effect, Types of equilibrium, phase change, fuel cell, combustion.

Unit III:
Simple vapour cycles, Rankine cycle, actual Vapour cycle processes, comparison of Rankine and Carnot cycle, Reheat cycle, Regenerative cycle, Binary vapour cycles.

Unit VI:
Reversed Heat engine cycles and heat pump, Bell Coleman cycle, Simple vapour compression refrigeration cycle, Absorption refrigeration, Properties of atmospheric air, Psychometric chart & processes.

D. Teaching/Learning/Practice Pattern:
Teaching: 60%
Learning: 40%
Practice: 0%

(Teacher is to divide components for T/R/P)

E. Examination Pattern:
1. Theoretical Examination.
F. Reading List:
Books:
1. Y. A. Cengel and M. A. Boles, “Thermodynamics - An Engineering Approach”, TMGH.
6. M. M. ElWakil, Power Plant Technology, MGH.

Magazine:
1. Cosmos.
2. Discover.
3. Every day Science.
5. Forge.

Journals:

Name of the Module: Engineering Materials and Processes
Module Code: ME 402
Semester: 4th
Credit Value: 5 [P=3, T=0, L=3]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. Perform as engineering leaders in the global marketplace.
2. Understand and apply the principles of Math, Science, and Engineering in design and Manufacturing related activities.
3. Contribute to the profitable growth of manufacturing businesses.
4. Maintain high standards of professional and ethical responsibility.

B. Learning Outcome:
Upon completion of the subject, the students should be able to demonstrate:
1. Knowledge of mathematics, science, and engineering.
2. To design and conduct experiments, as well as to analyse and interpret data.
3. To design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. The ability to function on multidisciplinary teams.
5. The ability to identify, formulates, and solves engineering problems.
6. An understanding of professional and ethical responsibility.
7. An ability to communicate effectively.
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
9. Recognition of the need for, and an ability to engage in life-long learning.
10. The knowledge of contemporary issues.
11. The ability to use the techniques, skills, and modern engineering tools necessary for engineering.

C. Subject Matter:


Unit II: Casting: various types of patterns and allowances, mould materials and their properties, strength, permeability and hardness, moulding. Basic principles of solidification, Cupola, terminology. Brief descriptions of the special casting processes, shell moulding, investment casting, die casting and centrifugal casting. Casting defects, Design consideration.


Unit IV: Metal forming processes: Re-crystallisation temperature, hot and cold working, Rolling, forging, drawing, extrusion, metal forming defects, Design consideration.

D. List of Practical:
1. To prepare a sand mould, using single piece pattern.
2. To prepare a sand mould, using split, loose piece pattern with a core.
3. To perform sand testing to determine properties like permeability, clay content, moisture, etc.
4. To perform sand testing to determine green sand and dry sand shear and compressive strength.

E. Teaching/Learning/Practice Pattern:

Teaching: 60%
Learning: 20%
Practice: 20%

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:

Books:
1. Boothroyd, ‘Fundamental of Metal machining and machine tools’. MGH.
2. P. N. Rao, ‘Manufacturing Technology (Vol I & II)’, TMGH.
Magazine:
1. Processing.
2. Infor.

Journals:

Name of the Module: Fluid Mechanics II
Module Code: ME 403
Semester: 4th
Credit Value: 5[P=3, T=0, L=3]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. Understand the fundamentals of fluid mechanics, including concepts of mass and momentum conservation.
2. Apply the Bernoulli equation to solve problems in fluid mechanics.
3. An ability to apply control volume analysis to problems in fluid mechanics.
4. An ability to use potential flow theory to solve problems in fluid mechanics.
5. An ability to perform dimensional analysis for problems in fluid mechanics.
6. Knowledge of laminar and turbulent boundary layer fundamentals.
7. An exposure to recent developments in fluid mechanics, with application to aerospace systems.
8. An ability to apply the concepts developed for fluid flow analysis to issues in aerospace design.

B. Learning Outcome:
Upon completion of the subject, the students should be able to demonstrate:
1. Knowledge of basic fluid dynamics.
2. Knowledge of control volume analysis.
3. An ability to use differential equations to understand pressure and velocity variations.
4. Knowledge of dimensional analysis.
5. An ability to determine ‘losses’ in flow systems.
6. Understanding of viscosity and its importance in real flows.

C. Subject Matter:
Unit I:
Boundary Layer Theory: Navier-Stokes equation, Laminar and Turbulent boundary Layer thickness, von Karman’s momentum equation, Total drag due to Laminar and turbulent layers on flat plate, separation of boundary layer and it’s control.
Forces on submerged bodies: Drag and lift on a stationary body by flowing fluid, expression for drag and lift and dimensional analysis, streamlined and Bluff, Drag on a sphere and cylinder, Terminal
velocity of a body, lift on a airfoil. Potential flow: source, sink, doublet, Rankine oval, lift on rotating cylinder.

Unit II:
**Compressible flow of Gas dynamics:** Thermodynamic relations, continuity equation, Bernoulli’s equation and momentum equation, velocity of sound in fluid, Mach no. propagation of pressure waves in a compressible fluid-Machangle, zone of action and silence, stagnation properties, Area-velocity relationship for compressible flow, flow of compressible fluid through nozzles-maximum mass flow rate and its variation, mass flow rate of compressible fluid through venturimeter, pitot-static tube, Normal and oblique shock waves.

Unit III:
**Hydraulic turbines:** Pelton, Francis, and Kaplan turbines, Turbine efficiencies, Cavitation in and centrifugal turbines.
**Centrifugal pumps:** Theory, components, and characteristics, Cavitation, Axial flow pumps, pump system matching.

Unit IV:
**Centrifugal and axial flow fans and compressors:** slip, surging and Chocking.
**Steam turbines:** basic cycle, impulse and reaction turbines.
**Gas turbine:** basic cycle and multistage, Power and efficiency calculations, Cascade Theory.

D. List of Practical:
1. To determine co-efficient of discharge of flow nozzle meter.
2. To determine co-efficient of discharge of triangular notch and rectangular notch.
3. To determine impact of jet.
4. To study the characteristics and performance of a Pelton turbine.
5. To study the characteristics and performance of a Francis turbine.
6. To study the characteristics and performance of a Kaplan turbine.

E. Teaching/Learning/Practice Pattern:

Teaching: 70 %
Learning: 20 %
Practice: 10%

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:

Books:
2. F. M. White, “Fluid Mechanics”, TMGH.
A. Objectives:
The course is design to meet with the following objectives:

1. To learn different Mechanism of Machine.
2. To learn different working principle of different types of Gears, Brakes, Cams.
3. To Learn how to Draw Velocity and Acceleration diagram for kinematics pairs.

B. Learning Outcome:
Upon completion of the subject, students should know:

1. Different mechanism of Machine.
2. Different working principle of different types of Gears, Brakes, Cams.
3. Know to draw Velocity and Acceleration diagram for kinematics pairs.

C. Subject Matter:
Unit I:
**Machine and mechanism:** Definition, Mechanism and Machine, Link, Kinematic Pair, Degrees of freedom, Kinematic chain, Various types of joints, Degrees of freedom for plain Mechanism, Inversion, Different types of kinematic chain and their inversions.

Unit II:
**Velocity and acceleration in mechanism:** Analysis of Reciprocating Engine mechanism and Four bar mechanism, Relative velocity method, Velocity and acceleration in Four bar, Slider crank Mechanism, Instantaneous center Method, Kennedy’s Theorem, Mechanical Advantage, Corioli’s Acceleration Component, Synthesis of Mechanism, Pantograph, Scott-Russel indicator diagram, Daris and Ackermenn steering mechanism, Hook’s joint, Belt, Rope and Chain drive.

Unit III:
Brakes and Dynamometers: Introduction, Types of Brakes (Simple Block, Band, Band & Block brake), Breaking of a Vehicle, Dynamometer, Absorption and transmission Dynamometer.

Gears and Gear Train: Introduction, Gear classification and Terminology, Law of Gearing, Velocity of sliding, Forms of teeth, length of Arc & path of contact, Interference, Minimum number of teeth required to avoid interference, Types of Gear Train, Velocity ratio indifferent Gear train arrangement, Epicyclic Gear train, compound Epicyclic Gear train.

Unit IV:
Cams: Introduction, Types of followers, Cam profile Nomenclature, various types of motion of the follower-Uniform motion, Simple Harmonic, Uniform Acceleration and Retardation, Cycloidal, Cam profile construction for various types of followers.

D. Teaching/Learning/Practice Pattern:

  Teaching: 70%
  Learning: 30%
  Practice: 0%

(Teacher is to divide components for T/R/P)

E. Examination Pattern:
1. Theoretical Examination.
2. Assignments.

G. Reading List:
Books:

Magazine:
1. Power Transmission Engineering.
2. Gear Technology.
3. Gear Solution.

Journals:
4. The International Federation for Theory of Machines and Mechanisms.
Name of the Module: Machine Drawing  
Module Code: ME 452  
Semester: 4th  
Credit Value: 3[P=3, T=0, L=0]  
Module Leader:  

A. Objectives:  
The course is designed to meet with the following objectives:  
1. To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyse, design and/or select commonly used machine components.  
2. To illustrate to students the variety of mechanical components available and emphasize the need to continue learning.  
3. To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.  
4. To teach students how to apply computer based techniques in the analysis, design and/or selection of machine components.  

B. Learning Outcome:  
Upon completion of the subject, students will be able to:  
1. Understand drawing and develop capacity to represent any matter/object with the help of picture.  
2. Develop primary knowledge of working drawing.  
3. Produce orthographic drawing of different machine parts.  
4. Develop skill to produce assembly drawings.  
5. Develop skill to produce detailed drawings of machines parts from assembly drawing.  

C. Subject Matter:  
Unit I:  
Different sectional views of the Machine parts, Keys, Splines, Couplings and Valves.  

Unit II:  
Bearing: Sliding and Rolling contact Types, Brackets and Pulleys, Cotter and Knuckle.  

Unit III:  
Joints: Riveted joints, laminated joints.  
Assembly Drawing: Introduction, Types of assembly drawing, valves, different machine parts.  

D. List of Practical:  
1. Draw the sectional views of different machine parts.  
2. Assembly drawing of screw jack, tailstock, valves.  
3. To draw Rivets joints lap and butt with zig-zag and chain system.  

E. Teaching/Learning/Practice Pattern:  
Teaching: 20 %  
Learning: 10 %  
Practice: 70 %  

(Teacher is to divide components for T/R/P)
F. Examination Pattern:
   1. Practical Drawing.
   2. Assignment.

G. Reading List:
Books:

Magazine:
   2. Design to Part Magazine.

Journals:

Name of the Module: Entrepreneurship and Innovation:
Module Code: HSS 401
Semester: 4th
Credit Value: 3 [P=0, T=0, L=3]

A. Objectives:
The course is design to meet with the following objectives:
   1. Students will be able to involve themselves in the business activities.
   2. Students will be able to start innovative practices in their entrepreneurial activities.
   3. Students will be able to develop their skills on the traits that they want to carry forward.
   4. Students will be able to start activities on Forest based Technology.

B. Learning Outcomes:
Upon completion of the subject, students will be able to:
   1. Start their venture more scientifically.
   2. Start their venture by linking with the financial institutions.

C. Subject Matter:
Unit I:
   Introduction to Entrepreneurship: Meaning, Role of Entrepreneur.
   Entrepreneur Process: different approaches, Motivation for becoming an Entrepreneur, SME Concept, its role, status, prospects and policies for promotion of SMEs.
Importance of Entrepreneurship: innovations, Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Issues & Problems Entrepreneurial Practices.

Unit II:
Importance of Entrepreneurship innovations: Converting Innovation to Economic Value which includes, Growth Strategies, value position, Market Segments, Value Chain Structure, Revenue Model etc., Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur and Issues & Problems Entrepreneurial Practices.


Entrepreneur Carrier: Different Stages, Entrepreneur Development Programmers (EDPs).

Unit III:

Women Entrepreneurship: Opportunities, promotion Hurdles and Prospects of women Entrepreneurs, Factors & Models of Entrepreneurial Development.

Social Entrepreneurial Initiative: Solving social Problems, Business plan, Strategic Plan vs Business Plan.

Unit IV:
Forest based Industries: Mobilization of resources from NTFP products, Processing units, Technical and Financial Feasibility study and analysis of projects under self employment scheme including small entrepreneur.

Farm based enterprises for production and post production of Agri-produce:
Livestock production: Poultry, Fishery, Medicinal and Aromatic plants.

Handlooms & Sericulture: Handicraft, coir, jute & leather, Micro entrepreneurial skills development and good production practices.

D. Teaching/ Learning/ Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

E. Examination Pattern:
1. Theoretical Examination.

F. Reading List:
Books:
Magazines:
1. Longe Magazine.
3. Entrepreneur.

Journals:
Name of the Module: Machine Design –I
Module Code: ME 501
Semester: 5th
Credit Value: 5[P=3, T=0, L=3]
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:

1. To teach the students the basic steps forming the design process and demonstrating the fact that design problems are open-ended, require creativity and involve iterative solutions.
2. To teach the students design methodologies and fundamentals and show their applications in linkages and mechanisms.
3. To teach the students position analysis as an integral part in the process of design for motion.
4. To teach the students the design of basic mechanisms, which meet, key performance requirements.
5. To teach the students the design of mechanisms for different types of output motions.
6. To introduce the students state-of-the-art CAD/CAE technology (e.g. Pro/Mechanical and I-DEAS) as powerful computer tools which can aid the problem-solving and design process.
7. To provide the students with hands-on experience in mechanism design through lab experiments.
8. To help the students develop effective/professional written and oral communication skills.

B. Learning Outcome:
Upon completion of the subjects, students will be able to:
1. Identify and describe the motion of typical mechanisms.
2. Operate and explain the function of typical mechanisms.
3. Utilize computer-aided design tools in engineering design problems.
4. Develop computer programs for design and parametric study of mechanisms.
5. Design at least one experiment.
6. Demonstrate knowledge of typical common manufacturing processes.
7. Demonstrate knowledge of rapid prototyping.

C. Subject Matter:
Unit I:

Unit II:
- Stresses in machine elements: Types of simple stresses, Stress strain relationship.
- Design for Strength: Design for static loading, Stress concentration factors.
- Design for variable loading.
- Fasteners: Types of fasteners, Design of Cotter and knuckle joint, Design of Key.
- Coupling: Types use, Design procedure, working principle of rigid and flexible rubber-bushed couplings.

Unit III:
- Design of Permanent Joints: Rivets, Types and use of rivet joint, Types and efficiency, design procedure, Welded joint, Bolted Joint.
- Power Screws: Power Screw, drives and their efficiency, Design of power screws.

Unit IV:
- Design of Shaft: shaft and its design based on strength, Design of shaft for variable load and based on stiffness, combined bending and twisting moment.

D. List of Practical:
1. Design/Drawing of Cotter and knuckle joint.
2. Design/Drawing of Key.

E. Teaching/Learning/Practice Pattern:
- Teaching: 60 %
- Learning: 20 %
- Practice: 20 %

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination and Open book examination.
2. Assignment.
3. Practical Drawing.

G. Reading List:
Books:
1. J. E. Shigley, ‘Mechanical Engineering Design’ MGH.
2. V. B. Bhandari, ‘Design of Machine element’ TMGH.
5. R. L. Norton, 'Design of Machinery', MGH.

Magazine:
2. Design to Part Magazine.

Journals:

Name of the Module: Internal Combustion Engines
Module Code: ME 502
Semester: 5th
Credit Value: 5[P=3, T=0, L=3]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. To make students familiar with the design and operating characteristics of modern internal combustion engines.
2. Apply analytical techniques to the engineering problems and performance analysis of internal combustion engines.
3. To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions.
4. To introduce students to the environmental and fuel economy challenges facing the internal combustion engine.
5. To introduce students to future internal combustion engine technology and market trends.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Differentiate among different internal combustion engine designs.
2. Recognize and understand reasons for differences among operating characteristics of different engine types and designs.
4. Based on an in-depth analysis of the combustion process, predict concentrations of primary exhaust pollutants.
5. Exposure to the engineering systems needed to set-up and run engines in controlled laboratory environments.
6. Develop skills to run engine dynamometer experiments.
7. Learn to compare and contrast experimental results with theoretical trends, and to attribute observed discrepancies to either measurement error or modelling limitations.
8. Develop an understanding of real world engine design issues.
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9. Develop an ability to optimize future engine designs for specific sets of constraints (fuel economy, performance, emissions).
10. Through the use of both theoretical techniques and experimentation, develop an appreciation for theoretical and practical limits to engine performance and fuel economy.

C. Subject Matter:
Unit I:

Unit II:
Elementary carburettor, complete carburettor, petrol injection, Diesel injection system, fuel pump, fuel injectors and nozzles, Battery ignition system, Magneto injection system, Electronic ignition system using contract breaker, ignition system and spark advance.

UNIT III:

UNIT IV:

D. List of Practical:
1. To study the functioning of injector and injector pump of C. I engine with sketches.
2. To study the functioning of carburettor of S.I engine with sketches.
3. To study the functioning of ignition system of SI engine with sketches.
4. To study the lubrication system of I C engine with sketches.
5. To study the cooling system of I C engine with sketches.
6. To find the brake power, brake specific fuel consumption, brake thermal efficiency of CI engine and draw the performance curve.

E. Teaching/Learning/Practice Pattern:

   Teaching: 60%
   Learning: 20 %
   Practice: 20%

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:
Books:
5. V. Ganesan, ‘Internal Combustion Engines’, TMGH.

Magazine:
1. Model Engine Builder.
2. Car and Driver.

Journals:

Name of the Module: Heat Transfer
Module Code: ME 503
Semester: 5th
Credit Value: 5[P=2, T=0, L=4]
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:
1. Analyse heat conduction using Fourier’s Law.
2. Analyse convective heat transfer.
3. Analyse unsteady convective heat transfer.
4. Analyse radiation heat transfer.
5. Solve the heat diffusion equation.
6. Evaluate thermal resistances.
7. Determine overall heat transfers coefficients.
8. Design double pipe heat exchangers.
10. Determine heat transfer from fins.
11. Analyse one-dimensional unsteady state heat transfer.
12. Utilize heat transfer coefficient correlations.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Understand the basic laws of heat transfer.
2. Account for the consequence of heat transfer in thermal analyses of engineering systems.
3. Analyse problems involving steady state heat conduction in simple geometries.
5. Obtain numerical solutions for conduction and radiation heat transfer problems.
6. Understand the fundamentals of convective heat transfer process.
7. Evaluate heat transfer coefficients for natural convection.
8. Evaluate heat transfer coefficients for forced convection inside ducts.
9. Evaluate heat transfer coefficients for forced convection over exterior surfaces.
10. Analyse heat exchanger performance by using the method of log mean temperature difference.

C. Subject Matter:

Unit I:
**Introduction:** Various methods of heat transfer, Fourier’s, Newton’s and Stefan Boltzman’s Law, Combined modes of heat transfer, thermal diffusivity, overall heat transfer coefficient.

**Conduction:** The thermal conductivity of solids, liquids and gases, factor influencing conductivity, measurement, the general differential equation of conduction, One dimensional steady state conduction, linear heat flow through a plane and composite wall, tube and sphere, critical thickness of insulation. Effect of variable thermal conductivity. Conduction with heat sources, heat transfer from rods heated at one both ends, Heat transfer from fins of uniform cross-section, Errors of measurement of temperature in thermometer wells.

Unit II:
**Convection (Forced):** Introduction, laminar boundary layer equations on a flat plate and in a tube, laminar forced convection on a flat plate and in a tube, simple Reynold’s analogy, Dimensional analysis of forced convection and empirical relationship for forced convection.

**Convection (Natural):** Dimensional analysis of natural convection, empirical relationship for natural convection, Convection with phase change, Description of condensing flow, A theoretical model of condensing flow, Boiling heat transfer, Empirical relationships for convection with phase change.

**Heat Exchangers:** Different types of heat exchangers, Determination of heat exchanger performance, Heat exchanger transfer units, Analysis restricted to parallel and counter flow heat exchanger, Effectiveness, NTU.

Unit III:
**Thermal Radiation:** Introduction, absorption and reflection of radiant energy, Emission, Radiosity and irradiation, Black and non-black bodies, Kirchhoff’s law, intensity of radiation, radiation exchange between black surface, geometric configuration factor, grey body relation exchange between surfaces of unit configuration factors, Grey body relation exchange between surfaces of unit configuration factors, Electrical analogy to simple problems, Non-luminous gas radiation, Errors in temperature measurement due to radiation.

Unit IV:
**Introduction to Mass Transfer:** Mass and mole concentrations, molecular diffusion, eddy diffusion, Molecular diffusion from an evaporating fluid surface, Introduction to mass transfer in laminar and turbulent convection, Combined heat and mass transfer, the wet and dry bulb thermometer.

D. List of Practical:
1. Study of heat transfer through composite wall.
2. Study of heat transfer through lagged pipe.
3. Study of heat transfer through fin.
4. Study of un-steady state of heat transfer.
5. Study of heat transfer in forced convection.
8. Study of heat transfer through fin tube heat exchanger.
10. Study of critical heat flux in boiling.
11. Determination of Stefan-Boltzmann constant experimentally.

E. Teaching/Learning/Practice Pattern:

Teaching: 60%
Learning: 20%
Practice: 20%

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:
Books:
2. J. P. Holman, ‘Heat Transfer’, MGH.

Magazine:
1. Process Cooling.
2. Forge.

Journals:

Name of the Module: Measurements and Metrology
Module Code: ME 504
Semester: 5th
Credit Value: 4[P=2, T=0, L=3]
Module Leader:
B. Learning Outcome:
Upon completion of the subject, student will be able to:
   1. Work in Quality control and quality assurances divisions in industries.
   2. Design a sensors and transducers used for stress analysis.
   3. Design measuring equipments for the measurement of temperature and flow.

C. Subject Matter:
Unit I:
   Introduction: Introduction to measurement and measuring instruments, Generalised measuring system and functional elements, units of measurement, Static and dynamic performance characteristics of measurement devices, Calibration , concept of error, sources of error, statistical analysis of errors.

Unit II:
   Sensors and Transducers: Types of sensors, types of transducers and their characteristics, Measurement of displacement and angular velocity
   Measurement of pressure: Gravitational, Direct acting, elastic and indirect type pressure transducers, Measurement of very low pressure.

Unit III:
   Strain Measurement: Types of strain gauges and their working, strain gauge circuits, Temperature compensation, Strain rosettes.
   Temperature Measurement: By thermometers, bimetallic, Thermocouples, thermistors and pyrometers.
   Measurement of Flow: Obstruction meters, Variable head meters, hot wire and magnetic meters, Ultrasonic flow meters etc.

Unit IV:
   Vibration and Noise measurement: Seismic Instruments, Vibration pickups and decibel meters.
   Limits, Fits & Tolerance: Introduction to various fits, limits & tolerances, Indian standards of fits & tolerances & grades, gauge design, Taylor’s principle of gauge design, wear allowances, measurement of concentricity & loaded surfaces.

D. List of Practical:
   1. Use Micrometer for measuring Go-Not Go plug gauge.
   2. Use Vernier for measuring piston.
   3. Use different angle measuring instruments for measuring taper plug gauge.
   4. Measure V Block with the help of Vernier height gauge.
   5. Measure V Block by Dial indicator set up.
   6. Measure different elements of screw threads.
   7. Measure different elements of gear.

E. Teaching/Learning/Practice Pattern:
   Teaching: 70%
   Learning: 30%
   Practice: 10 %

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
   1. Theoretical Examination.
2. Practical Examination.

G. Reading List:

Books:
1. J. P. Holman, Experimental Methods for Engineers, MGH.
3. E. O. Doebelin, Measurement Systems- Application and Design, MGH
4. B. C. Nakra and K. K. Chaudhary, Instrumentation, Measurement and Analysis, TMGH.
6. D. L. Kumar, ‘Mechanical Measurement & Instrumentation’

Magazine:
1. Cal Lab.
2. Gear Solution.
3. Quality Digest.

Journals:
3. The International Journal of Metrology.

Name of the Module: Manufacturing Technology
Module Code: ME 505
Semester: 5th
Credit Value: 5 [P=3, T=0, L=3]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. To make them aware of various metal cutting processes and available tool nomenclature systems.
2. To understand various available abrasive processes and surface finishing processes.
3. To understand various general purpose machine tools and their working.
4. To make them aware of non-conventional machining processes and methods.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Compare traditional manufacturing to advanced manufacturing and explain the benefits and importance of the latter.
2. Define advanced machining and explain its key elements.
3. Explain the key elements of a CNC machine tool system (control system, machining process and NC programming).
4. Demonstrate knowledge of machining theory and principles.
5. Operate safely a typical modern CNC machine tool.
6. Conduct the basic procedures on CNC machine tools.
7. Write sound NC programs for milling, turning and drilling.
8. Communicate effectively through written report.
9. Implement NC verification using simulation tools.
10. Explain the use of CAD/CAM technology in advanced machining.
11. Demonstrate a knowledge and understanding of machining process optimization.
12. Follow/use best practice when developing NC programs and/or running cutting operations on a typical CNC machine tool.

C. Subject Matter:

Unit I:
Classification of metal removing processes and machines.

Mechanics of Metal Cutting: Geometry of single point cutting tool and tool angles, Tool nomenclature in ASA, ORS and NRS And interrelationship, Mechanism of chip formation and types of chips, Chip breakers, Orthogonal and oblique cutting, cutting forces and power required, Theories of metal cutting, Thermal aspects of machining and measurement of chip tool interface temperature, Friction and metal cutting.

Machinability: Concept and evaluation of Machinability, tool life, mechanisms of tool failure, Tool life and cutting parameters, Machinability index, Factors affecting Machinability.

Cutting Fluid: Types, Selection and application methods.

UNIT II:
General Purpose Machine Tools: Constructional, details of lathe, drilling, milling, shaping and planning machines, Tooling, attachments and operations performed , selection of cutting parameters, Calculation of forces and time for machining, Broaching operation.

Capstan and turret lathes: single and multiple spindle automates, operations planning and tool layout.

UNIT III:
Abrasive Processes: Abrasives natural and synthetic, manufacturing nomenclature, Selection of grinding wheels, Wheel mounting and dressing, Machines for surface and cylindrical grinding, their constructional details and processes.

Surface Finishing: Honing, Lapping and super-finishing, polishing and buffing processes, Screw threads and gear manufacturing methods.

UNIT IV:
Non-Conventional Machining: Benefits, general applications and survey of non-conventional machining processes, Mechanisms of metal removal, tooling and equipments, process parameters, surface finishing obtained and specific application of EDM, LBM, EBM, ECM, USM, AJM processes.

D. List of Practical:
1. To calculate the different angles of a single point cutting tool.
2. To determine the feed force, cutting force varying depth of cut, feed and speed using lathe tool dynamometer.
3. To construct a merchant circle.
4. To perform a gear cutting operation on milling machine.

E. Teaching/Learning/Practice Pattern:

Teaching: 60 %
Learning: 30 %
Practice: 20 %
(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:
Books:
2. B. S. Raghuwanshi, 'A course in Workshop Technology' (Vol. I & II), TMGH.
3. P. N. Rao, 'Manufacturing Technology', TMGH.
5. B. S. Nagendra Parashar and R. K. Mittal, 'Elements of Manufacturing Processes', PHI.

Magazines:
1. International Metal Working News.
2. Industrial Distribution.
4. Discover.

Journals:
2. Journal of Manufacturing Science and Engineering, Transactions of the ASME.

Name of the Module: Industrial Engineering & Management
Module Code: ME506
Semester: 5th
Credit Value: 3\([P=0, T=0, L=3]\)
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. Competently employ broad-based analytical tools and computers for decision-making and system design, analysis and performance.
2. Assume managerial and leadership roles in their chosen professional careers while working in multidisciplinary teams.
3. Engage in continuous learning by seeking out opportunities for higher education or ongoing training related to their employment.
B. Learning Outcome:
Upon completion of the subject, students will be able to:
2. Design and conduct experiments, as well as to analyse and interpret data.
3. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
4. Function on multi-disciplinary teams.
5. Identify, formulate and solve engineering problems.
6. Understand the professional and ethical responsibility.
7. Communicate effectively.
8. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
9. Recognize the need for, and an ability to engage in life-long learning.
10. Develop knowledge of contemporary issues.
11. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

C. Subject Matter:
Unit I:  
**Industrial Engineering**: Concept of Industrial Engineering, its role & applications, Operation Research.
**Work study**: time & motion study, Method study, Principles of motion economy, Workplace layout, Stopwatch time study, SIMO chart, Man-machine chart, Therbligs, PMTS, MTM, Work sampling.
**Organisation**: Organisation structures, Types, Principles of organization structures, Features of various Ownerships, Company formations, its management and finance, Public limited & private limited company.

Unit II:  
**Material Management**: Functions of material management, Inventories- its types, Just In Time (JIT) inventory, Concept of EOQ & EBQ, Simple EOQ model with and without stock outs, Simple EOQ model with varying demand and production, P-type & Q-type of inventory policies, Selective inventory control like ABC, VED, SDE techniques etc.
**Production Planning & Control**: Functions and role, Value analysis, Exponential smoothing constant and moving average method in demand and production forecasting, Break even analysis.

Unit III:  
**Quality Management**: Quality v/s reliability, Quality maintenance and quality assurance, SQC technique, Acceptance sampling, Concept of TQM, ISO Standards.
**Plant Layout**: Location factors, Principles and design, Types of layout, Tools & technique.
**Plant Maintenance**: Break down, Scheduled and Preventive maintenance, Steps in preventive maintenance, TPM concept.

Unit IV:  
**Operational Research**: Concept of O. R, Methods of O.R, Concept of optimization, Linear programming, simplex method Transportation problem, Queuing theory. Decision theory, Integer programming, Revised simplex method, network techniques (PERT & CPM), theory of games, Simulation

D. Teaching/Learning/Practice Pattern:
Teaching: 70 %
Learning: 30: %
Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:
1. Theoretical Examination.

F. Reading List:
Books:
3. S. N. Chary, ‘Production and Organisation Management’ TMGH.
7. Martinch, ‘Production and Operation Management’, WSE.
8. Ralph M. Barnes, ‘Motion and Time Study: Design and measurement of work’ Wiley.

Magazine:

Journals:
1. International Journal of Industrial Engineering and Production Management.
Name of the Module: Dynamics of Machinery

Module Code: ME 601
Semester: 6th
Credit Value: 5\( \{P=3, T=0, L=3\} \)

Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:

1. Fully understand and appreciate the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions.
2. Be able to obtain linear vibratory models of dynamic systems with changing complexities (SDOF, MDOF).
3. Be able to write the differential equation of motion of vibratory systems.
4. Be able to make free and forced (harmonic, periodic, non-periodic) vibration analysis of single and multi-degree of freedom linear systems.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Appreciate the need and importance of vibration analysis in mechanical design of machine parts that operate in vibratory conditions.
2. Analyse the mathematical model of a linear vibratory system to determine its response.
3. Obtain linear mathematical models of real-life engineering systems.
4. Use Lagrange’s equations for linear and nonlinear vibratory systems.
5. Determine vibratory responses of SDOF and MDOF systems to harmonic, periodic and non-periodic excitation.
6. Have a general notion on frequency and time response of vibratory systems.
C. Subject Matter:

Unit I:

Unit II:
Dynamically Equivalent System Gyroscopes: Gyroscopic Forces and Couples, Gyroscopic Effects in Machines, Stability of a Four Wheel and Two Wheel Drive Vehicle.

Unit III:
Governor: Speed Control By Governors, Dynamics of Governor Mechanisms, Different Types of Governors, Performance Parameter, Governor Effort and Power, Control Force.

Unit IV:

D. List of Practical:
1. To study the use and significance of a Gyroscope.
2. To study about reciprocating mass balancing.
3. To study about different profiles of a cam.
4. To study about vibration on a Universal vibration apparatus.
5. To calculate natural frequency of specified object.
6. To study the Governor characteristics (Porter, watt).

E. Teaching/Learning/Practice Pattern:

Teaching: 70 %
Learning: 20 %
Practice: 10 %

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:
Books:
Magazine:
1. Sound and vibration.
2. Acoustic.

Journals:
1. Journal of the Vibration Institute of India.

Name of the Module: Machine Design – II
Module Code: ME 602
Semester: 6th
Credit Value: 4 [P=2, T=0, L=3]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. To teach students velocity and acceleration analysis as an integral part in the process of design.
2. To teach students static and dynamic force analysis as an integral part in the process of design.
3. To teach students balancing of machines.
4. To teach students the design of mechanical components such as cams, gears, springs, screws, and clutches, which meet the given design criteria, including strength requirements.
5. To teach students the design of mechanical systems such as cam-followers and gear train, which meet key performance requirements, including motion and dynamic performance.
6. To teach students state-of-the-art CAD/CAE technology (e.g., Pro/MECHANICA and I-DEAS) and show them how such powerful computer tools can aid the problem-solving and design process.
7. To provide the students with hands-on experience in the design and analysis of mechanical systems through lab experiments.
8. To help the students develop effective/professional written and oral communication skills through report writing and oral presentation.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Identify the mechanical system that satisfies the given engineering requirements. Describe the necessary assumptions in designing mechanical systems.
2. Apply proper engineering principles and theories to solve open-ended design problems.
3. Perform kinematic and dynamic analyses using both graphical and analytical techniques.
4. Perform mechanism analysis and simulation using computer tools.
5. Evaluate the performance of mechanical systems.
6. Design linkages, cams, gears and other machine elements for both motion and strength requirements.
7. Communicate design work through written report and oral presentation.
8. Conduct Library/Internet search of patents/literature.
9. Explain the potential impact of designed mechanical systems on environment and society, including safety.

C. Subject Matter:
Unit I:
Fatigue Consideration in Design: Variable load- basic concept, Patterns of load or stress variations, S-N curve fatigue strength and endurance limit, Factors influencing fatigue, Effect of stress concentration and fatigue stress concentration definition and its estimation from geometric stress concentration factor, Goodman and Soderberg's relations, design for infinite life and finite life, Methods for design of members under combined (steady and variable) loading conditions, Worked out examples on fatigue design problems.

Unit II:
Design of Gear Tooth: Gears-types and application and gear terminology, Analysis of forces on spur, and helical gears, Bending and contact stress in gear tooth, Lewis equation for design, Dynamic loading and wear-Buckingham equations for design, Force analysis on bevel and worm gears, Design approach for bevel gears- equivalent tooth, Design of fixed ratio gear box- general design procedure, Determination of bearing reaction due to gear forces.

Unit III:
Design of Sliding and Journal Bearings: Types of lubrication- hydro dynamic, hydro static and EHD lubrication, Petroff's equation and the bearing characteristic number, Lubrication regimes-boundary and film lubrication, Hydro dynamic bearings- Pressure distribution- eccentricity and minimum film thickness, Reynolds equation, Heat generation and thermal equilibrium.

Unit IV:
Design/analysis of Brakes clutches and fly wheels: Brakes and clutches -need and functioning, Plate clutches- design for uniform pressure and wear, brake-design/analysis, Flywheel- Coefficient of fluctuation of speeds, fluctuation of energy, energy stored in flywheel. Stresses on flywheel ring, arms, Design of shafts, hub and Key, Design of flywheel.

D. List of Practical:
1. Design/Drawing of Gear.
2. Design/Drawing of Gear tooth.

E. Teaching/Learning/Practice Pattern:
  Teaching: 40 %
  Learning: 20 %
  Practice: 40 %

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretic Examination and Open book examination.

G. Reading List:
Books:
1. J. E. Shigley, ‘Mechanical Engineering Design’, MGH.
2. V. B. Bhandari, ‘Design of Machine element’, TMGH.
5. R. L. Nortron, ‘Design of Machinery’, MGH.
A. Objectives:
The course is design to meet with the following objectives:

1. Analysis and preliminary design of the major systems of conventional fossil-fuel steam-cycle power plants.
2. A working knowledge of the basic design principles of nuclear, gas turbine, combined cycle, hydro, wind, geothermal, solar, and alternate power plants.
3. Awareness of the economic, environmental, and regulatory issues related to power generation.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Discuss the energy resources and energy conversion methods available for the production of electric power in the US and the world.
2. Determine the efficiency and output of a modern Rankine cycle steam power plant from given data, including superheat, reheat, regeneration, and irreversibilities.
3. Calculate the heat rate, fan power consumption, flame temperature and combustion air requirements of conventional steam generators (boilers).
4. Select the heat transfer tubes needed for condensers and feed water heaters.
5. Explain the blade shapes, and calculate work output of typical turbine stages.
6. Calculate the performance of gas turbines with reheat and regeneration, and discuss the performance of combined cycle power plants.
7. Explain the major types of hydro-power and wind-power turbines and estimate power generation potential.
8. Explain the basic principles of thermal-fission and fast-breeder nuclear power plants, such as pressurized-water, boiling-water, and heavy-water reactors.
9. Discuss power generation from renewable/alternate fuels and heat sources: bio-fuels, synthetic fuels, geothermal, ocean thermal, solar thermal power plants.
10. Discuss the principles and potential of direct-electric power conversion systems, such as fuel-cell and solar photovoltaic units.
11. Discuss the control methods of major pollutants emitted from fossil-fuel power plants.
12. Discuss the environmental impact of electric power production on air quality, climate change, water, and land.
13. Perform the preliminary design of the major components or systems of a conventional or alternate power plant.

C. Subject Matter:

Unit I
Power Plant in General: Introduction to different power plants, Load duration curves, Location of power Plants, Power plant economics and Indian energy scenario.

Steam Power Plant: Introduction, Rankine cycle, Carnot cycle, Reheating of steam, Regeneration, Steam power plant appraisal, Deaeration, Typical layout of steam power plant, Efficiencies in steam power plant, Co generation of power and process heat, Combined cycle power generation, Different types of fuel used for steam Generation, Draught system, Classification of boilers, Boiler accessories, Classification of steam turbines and their working, Fluidized bed.

Unit II
Gas Turbine Power Plant: Introduction, Classification of different gas turbine power plants, Reheat and regeneration cycle, Analysis of closed cycle and open cycle constant pressure gas turbine plant, components of gas turbine plants.

Diesel Electric Power Plants: Introduction, Application of diesel engines in power field, Advantages and disadvantages of diesel engine power plant, General layout, Performance characteristics, Supercharging.

Unit III
Hydro-Electric Power Plant: Introduction, Classification of hydro-electric power plant, Site selection, Elements of hydro-electric power plant, Advantages of hydro-electric power plant, Classification of hydraulic turbines and its selection, Hydrographs, Flow duration curves.

Nuclear Power Plant: Introduction to nuclear engineering, Types of nuclear reactors, Pressurized water reactor, Boiling water reactor, CANDU reactor, Gas-cooled reactor, Liquid metal fast breeder reactor, India’s nuclear power programme.

Unit IV
Non-Conventional Power plants: Prospect of renewable energy source, Types of non-conventional power plants, solar plants, Wind power plants, Bio-mass plants, Geo-thermal power plant, Tidal power plant.

D. List of Practical:
1. Study of a water tube boiler (Babcock Wilcox boiler).
2. Study of a locomotive boiler.
3. Study of a high pressure boiler.
4. Study of boiler accessories.
5. Trial on a boiler and heat balance sheet.
7. Study and trial on a steam turbine.
8. Study of condensers.
9. Study of condensate and air extraction pumps.
10. Study of steam power plant (Preferable visit of steam power plant).

E. Teaching/Learning/Practice Pattern:

Teaching: 70 %
Learning: 20 %
Practice: 10 %

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:
Books:
1. P. K. Nag, “Power Plant Engineering”, TMGH.
3. M. M. Elwakil, “Power Plant technology”, MGH.
5. Black and Veatch, “Power Plant Engineering”, MGH
6. F. T. Morse, “Power Plant Engineering”.

Magazine:
1. Process News, SEIMENS.
2. Plant Engineering.
3. Turbomachinery International.

Journals:
1. Journal of Energy Engineering, ASCE.

Name of the Module: Automation and Computerized Manufacturing
Module Code: ME 604
Semester: 6th
Credit Value: 5[P=3, T=0, L=3]
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:
1. Understanding manual and computer-assisted process planning.
2. Understanding fundamentals of industrial control components and systems.
3. Understanding PLC programming.
4. Understanding group technology and flexible/cellular manufacturing.
5. Understanding the role of robots in flexible/cellular manufacturing.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Built a strong background in manufacturing processes and materials for discreet piece part manufacture, considering nomenclature recognition, limits, costs, benefits, etc. of comparative processes and materials through a hands-on approach.
2. Have a strong mathematics, science, and computer skills with emphasis on programs that aid process and product analysis and control, as well as the ability to apply a concurrent approach to process, product, and equipment design with supporting technologies such as: DFM, DFA, CAD, CAM, CAE and rapid prototyping.

3. Identify, formulate, and solve manufacturing problems considering constraints, costs, benefits, and competitiveness of comparative processes and materials.

C. Subject Matter:
Unit I:
Gear Hobbing, Capstan and Turret lathe, Single spindle and multi spindle automatic lathes.

Unit II:
Machining centre, NC, CNC Machines: Types, Axis definition, Tool offset, CNC programming.
Flexible Manufacturing Systems (FMS) and Computer Integrated Manufacturing (CIM): Introduction to FMS, CIM, Types of FMS and CIM, Configuration and application.

D. List of Practical:
CNC-1: CNC Lathe Machine:
1. Understand operation procedures of the machine.
2. Demonstration of operating procedure with the help of a work piece.
3. Understand safety operations.

CNC-2: CNC Milling Machine:
1. Understand operation procedures of the machine.
2. Demonstration of operation procedure with the help of a work piece.
3. Understand safety operations.

CADD lab: Use of solid modelling, design and analysis using softwares like ANSYS, Pro E, CATIA etc.

E. Teaching/Learning/Practice Pattern:
Teaching: 70 %
Learning: 20 %
Practice: 10 %

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination.
2. Practical Examination.

G. Reading List:
Books:
1. Y. Koren, “Computer Control of Manufacturing System”, TMH.
6. V. B. Bhandari, “Design of Machine Element”, TMGH.

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Magazine:
1. International Metal Work News.
2. Industrial Laser Solution.

Journals:

Name of the Module: Numerical Methods in Engineering
Module Code: MAS 602
Semester: 4th
Credit Value: 4 [P=2, T=0, L=3]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. Introducing the basic concepts of round off error, truncation error, numerical stability and condition, Taylor polynomial approximations; to derive and apply some fundamental algorithms for solving scientific and engineering problems: roots of nonlinear equations, systems of linear equations, polynomial and spline interpolation, numerical differentiation and integration, numerical solution of ordinary differential equations.
2. Application of computer-oriented numerical methods which has become an integral part of the life of all the modern engineers and scientists. The advent of powerful small computers and workstation tremendously increased the speed, power and flexibility of numerical computing.
3. Injecting future scope and the research directions in the field of numerical methods.

B. Learning outcomes:
Upon completion of the subject, students will be able to:
1. Do Numerical Analysis, which is the study of algorithms for solving problems of continuous mathematics.
2. Know numerical methods, algorithms and their implementation in ‘C’ for solving scientific problems.
3. Substantially prepared to take up prospective research assignments.

C. Subject Matter:
Unit I:
Errors in computation: Overflow and underflow, Approximation in numerical computation, Truncation and round off errors, Propagation and control of round off errors, Chopping and rounding off errors, Pitfalls (hazards) in numerical computations (ill conditioned and well conditioned problems).

Unit II:
Unit III:

**Numerical Differentiation:** Use of Newton’s forward and backward interpolation formula only.

**Numerical Integration:** Trapezoidal formula (composite), Simpson’s 1/3rd formula (composite), Romberg Integration (statement only), Problems.

Unit IV:

**Numerical Solution of System of Linear Equations:** Gauss elimination method; Matrix Inversion, Operations Count, LU Factorization Method (Crout’s Method), Gauss-Jordan Method, Gauss-Seidel Method, Sufficient Condition of Convergence.

**Numerical Solution of Algebraic and Transcendental Equations:** Iteration Methods, Secant Method, Regula-Falsi Method, Newton-Raphson Method.

**Numerical solution of Initial Value Problems of First Order Ordinary Differential Equations:** Taylor’s Series Method, Euler’s Method, Runge-Kutta Method (4th order), Modified Euler’s Method and Adams-Moulton Method.

D. List of Practical: (Minimum six experiments are required to be performed)

1. Assignments on Interpolation: Newton forward & backward, Lagrange.

E. Teaching/Learning/Practice Pattern:

- Teaching: 40%
- Learning: 10%
- Practice: 50%

(Teacher is to divide components for T/R/P)

F. Examination Pattern:

1. Theoretical Examination: Open book and on line.
2. Practical Examination: Conducting Experiments and Viva-Voce.

G. Reading list:

**Books:**


Magazines:
2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of Sheffield).
5. Plus magazine (University of Cambridge).

Journals:
3. SIAM Review, University of Bristol, UK.
5. SIAM Journal on Numerical Analysis, University of Bristol, UK.
6. SIAM Journal on Scientific Computing, University of Bristol, UK.

Name of the Module: Engineering Ethics & IPR
Module Code: HSS 601
Semester: 6th
Credit Value: 3 [P=0, T=0, L=3]
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:
1. Imparting theoretical lectures with case discussion.
2. Providing teaching with inclusive learning.
3. Making students aware about the importance of this subject in their future

B. Learning outcomes:
Upon completion of the subject, students will be able to:
1. Work with efficiency as they had knowledge of the subject.
2. Perform much better in their workplace.

C Subject Matter:
Unit I:

Engineering as a profession: Historical and social context, Ethics in Engineering, Codes of Engineering Ethics, history and purpose, consequentialism and utilitarianism, Deontological approaches, duties, rights and respect for a person, responsibility, virtue Ethics, honesty, moral autonomy, obligations of Engineering profession and moral propriety.

Unit II:

Engineer’s moral responsibility: Safety and human right, risk assessment and communication, product liability, development ethics, engineers and employer relationship, whistle blowing and its moral justifications.

Unit III:

Computer Ethics: Social impact of computers, Computer and gender issues, privacy, cyber crime, ethical use of software’s, intrinsic value of nature.

Unit IV:

IPR I: Intellectual property, definition, types, rights and functions, patents, trademark, software design, industrial designs, semi-conductor and integrated circuits layout design, grant of patent in India, authority and procedure, patent forms, surrender and revocation of patents and compulsory licensing, acquisition of inventions by the Government.

IPR II: Contents of draft application for patents, Drafting patent specification and claims, WTO and drafting patent specification and claims, IPR infringement and piracy under Indian Laws.

D. Teaching/ Learning:

Teaching: 50%
Learning/ case presentation: 30%
Assignment: 10%
Attendance: 10%

E. Examination pattern:

1. Theoretical Examination: 50
2. Class test: 30
3. Assignment: 20

F. Reading list:

Books:
1. S. Chowdhury, “Blending the best of the East & West”, EXCEL
2. V. Ghosh, “Ethics and Mgmt. & Indian Ethos”.
3. Pherwani, “Business Ethics”, EPH.

Magazine:
1. Industry Week.

Journals:
2. The Journal of Ethics.
Name of the Module: Disaster Management
Module Code: HSS 602
Semester: 6th
Credit Value: 2 [P=0, T=0, L=2]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. Imparting theoretical lectures with case discussion.
2. Providing teaching with inclusive learning.
3. Making students aware of the importance of this subject in the future prospect.

B. Learning outcomes:
Upon completion of the subject, students will be able to:
1. Work with efficiency as they had knowledge of the subject.
2. Perform much better in their workplace.

C. Subject Matter:
Unit I:
    Introduction: Disaster preparedness, Goals and objectives of ISDR Programme, Risk identification, Risk sharing.
    Disaster and Development: Development plans and disaster management, Alternative to dominant approach, disaster-development linkages, Principle of risk partnership.

Unit II:
    Disaster Management and Risk Reduction in Garment Industry: Types of disasters and disaster plans, Processing machines and utilities, Sustainable livelihoods and their Protection, Recovery from disaster, fire, boiler mishap, Garment Industry health monitoring and Disaster aids.

Unit III:
    Awareness of Risk Reduction: Trigger mechanism, constitution of trigger mechanism, risk reduction by education, disaster information network and risk reduction by public awareness.

Unit IV:
    Development Planning on Disaster: Implication of development planning, financial arrangements, areas of improvement, disaster preparedness and community based disaster management, emergency response.
    Seismicity: Seismic waves, Earthquakes and faults, measures of an earthquake, magnitude and intensity ground damage, Tsunamis and earthquakes.

D. Teaching/ Learning/Practice Pattern:

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</table>
Assignment : 10%
Attendance : 10%

E. Examination pattern:
1. Theoretical Examination : 50
2. Class test : 30
3. Assignment : 20

G. Reading List:
Books:
3. MHA, GOI-UNDP, “Disaster Management in India”, 2009

Magazines:
1. Crises and Disaster Management Magazine.
2. Emergency Management.

Journals:
3. IDRIM Journal.
Name of the Module: Mass Communication for Technology  
Module Code: HSS 701  
Semester: 7th  
Credit Value: 3[P=0, T=0, L-3]

A. Objectives:  
The course is designed to meet with the following objectives:  
1. Imparting theoretical lectures with case discussion.  
2. Teaching with inclusive learning.  
3. Making students aware of the importance of this subject in their future career.

B. Learning Outcomes:  
Upon completion of the subject, students will be able to:  
1. Work with efficiency as they had knowledge of the subject.  
2. Perform much better in their workplace.

C. Subject Matter:  
Unit I:  
Fundamentals of Mass Communication: Definition of Mass Communication, importance, scope, importance, related fields, history of mass communication.

Unit II:  
Dissemination of Scientific & Technical Knowledge (DSTK): Difficulties with distribution of scientific and technical information is rapidly increasing with unprecedented spade of science and technology. Further, engineers are made to meet with this challenge. The subject should cover the knowledge so as to establish adequate and effective distribution of information. Lack of information cannot make a sound engineer. Engineers should be specialists in information dissemination for which a course on DSTK is of paramount importance. Engineers should be made to write articles and research papers fluently and confidently. They should be taught to organize seminar and conferences deliver
talks as well in the seminars and conferences. They should also be taught the technique of publishing magazines and journals.

D. Teaching/ Learning/ Practice Pattern:

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E. Examination pattern:

1. Theoretical Examination : 50
2. Class test               : 30
3. Assignment               : 20

F. Reading List:

Books:

Magazines:
1. Media and Communication.
2. Communication Magazine.

Journals:
1. Mass Review.
5. Communicator.
Name of the Module: Refrigeration and Air-Conditioning

Module Code: ME 701
Semester: 7th
Credit Value: 5[P=3, T=1, L=3]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. To study the characteristics and engineering design of heating, ventilating, air conditioning and refrigeration (HVAC & R) systems.
2. To enable students to achieve effective and efficient design solutions.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. To describe major design considerations of air-side, water-side, ventilation and refrigeration systems.
2. To evaluate applications and design calculations of HVAC & R systems.

C. Subject Matter:
Unit I:

Unit II:
Refrigeration Controls: liquid refrigerant control automatic & thermostatic expansion valves, float valves, section line controls.
Applications of Refrigeration: ice making, food preservation, household refrigerators, cold storage.
Psychometrics: Atmospheric air, air and humidity, terms and calculation, psychrometric chart, air humidity processes, humidification & dehumidification, By-pass factor, summer and winter air load, housing system.

Unit III:
Comfort Air conditioning: effective temperature, comfort chart, ventilation requirements.
Solar Radiation: Distribution of solar radiation, direct and diffuse radiation, earth sun angles and their relationships, direct solar radiation on a vertical, horizontal, inclined surface, heat gain through glass, effect of shading devices, heat transfer in building structures through walls and roofs, Empirical methods to evaluate heat transfer through walls and roofs, infiltration, passive heating and cooling of building, Air distribution system, basic theory, air duct losses, design of air duct system, air delivery and distribution.

Unit IV:
Air conditioning systems: unit conditioners, central air conditioning, control of air conditioning apparatus, space cooling load calculation, heat transmission through barriers, solar radiation, infiltration, occupants, electric lights & appliances, product load, outside air and ventilation, SHR Bypass factor, ADP, refrigeration load, Fluid flow and pressure loss, equivalent length system & duct design, air distribution system, basic control system, Solar heating and cooling, air conditioning through solar system, building designs for air conditioning.

D. List of Practical:
1. Study of domestic refrigerator, water cooler, Window air conditioners, split units etc.
2. To perform electrical practices like wiring, soldering.
3. To perform practices on evacuation and dehydration, leak detection, charging, etc.
4. To repair or perform servicing of condensers and evaporators.
5. Study of pressure drops in ducts.
6. To repair hermetically sealed units.
7. To perform complete servicing of a refrigerator.
8. To perform complete servicing of an air conditioner.
9. To determine Fault detection.
10. To adjust the automatic system.
11. To make wiring diagrams of an air conditioner and central plants.
12. To test safety and operating controls such as relay, thermostat, HP and LP Cut out, over load protector, solenoid valve, oil pressure, Failure control etc.
13. To carry out electric wiring of refrigerator bottle cooler.
14. To carry out electric wiring of window type air conditioner.

E. Teaching/Learning/Practice Pattern:

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(Teacher is to divide components for T/R/P)

F. Examination Pattern:
1. Theoretical Examination and Open book examination.
2. Practical Examination.

G. Reading List:

Books:
1. C. P. Arora, “Refrigeration and Air Conditioning”, TMGH.
3. Dosat, “Basic refrigeration”, MGH.
4. Prasad, “Refrigeration and air conditioning”, MGH.

Magazine:
1. Process Cooling.

Journals:
2. Refrigeration and Air Conditioning Manufacturers Association, RAMA.

Name of the Module: Creative Design
Module Code: ME 702
Semester: 7th
Credit Value: 2 [P=0, L=2, T=0]
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:
1. To learn basic Concept Mechanical systems design.
2. To learn basic consideration of safety factor in designing.
3. To learn design optimization with respect to efficient material and performance.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Understand safety factor in designing.
2. Optimize design for efficient performance.

C. Subject Matter:
Unit I:

Unit II:
Creative Problem Solving Techniques: Creative Process, Creativity Characteristics, Analysis of existing Design, Mathematical & Experimental Analysis.

Unit III:

Unit IV:

D. Teaching/Learning/Practice Pattern:
Teaching: 50 %
Learning: 50 %
Practice: 0%
(Teacher is to divide components for T/R/P)

E. Examination Pattern:
1. Theoretical Examination and Open book examination.

G. Reading List:
Books:
1. Simant, Mishra, Ramesh Chandra, “Mechanical System Design”, PHI.
5. Hong-sen-yon, “Creative Design of Mechanical Devices”, Springer

Magazine:
1. ES Engineering System.
2. Gear Solution.

Journals:
1. Journal of Mechanical Design, ASME.
2. Journal of Advanced Mechanical Design, Systems, and Manufacturing, JSME.

Name of the Module: Green Car Technology
Module Code: ME 705
Semester: 7th
Credit Value: 3 [P=2, T=0, L=2]
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:
1. Improve efficiency of automobiles.
2. Increase the security of automobiles.
3. To ensure increased safety of automobiles.
4. To increase the performance of automobiles using electronics and electrical technology.

B. Learning Outcomes:
Upon completion of the subject, students will be able to:
1. Describe construction, functions and applications of various sensors and actuators used in modern vehicle.
2. Explain modern Ignition systems of S.I. and C.I. Engines.
3. Explain latest advancement in Engine technology.
4. Identify and describe various advanced peripheral system used in automobile.
5. Demonstrate various safety features and equipment used in modern vehicle.
6. Identify various modern features for better functioning of vehicle.

C. Subject Matter:
Unit I:

Unit II:
Advanced Ignition System: Electrical & Electronics Ignition systems, Modern Spark Ignition System (DTSI, TDSI, Multi electrode etc system) Insulated Coils, Non-Battery Energy Storage-Ultra Capacitors and flywheels.

Unit III:
Advancement in Engine & related components: Introduction & types of hybrid car, Hybrid drive system, Solar cars, compressed air car, Basic components of Blue Motion Technology (DGG, TSI, TDI, GDI variable value timing system).

D. List of Practical:
1. Seminar on Industrial visit (Automobile Industry).

E. Teaching/ Learning/ Practice Pattern:

  Teaching: 40%
  Learning: 30%
  Practice: 30%

F. Examination Pattern:
1. Theoretical Examination/ Open Book.
2. Practical Examination.

G. Reading List:
Books:

Magazines:
1. Automobiles.
2. Top Gear.
4. Car and Driver.

Journals:
1. CIRP Journal of Manufacturing Science and Technology.
2. Journal of Power Sources.
3. Journal of Cleaner Production.
Semester- VIII

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Contact Hrs: 2; Credit: 16
List of Electives

ELECTIVE – I

Name of the Module: Combustion Engineering

Module Code: ME 703/1
Semester: 7th
Credit Value: 3[P=0, T=0, L=3]

Module Leader:

A. Objectives:
The course is design to meet with the following objectives:

1. To prepare the student for engineering analysis and design of combustion systems.
2. Assessment of fire and explosion hazards, based on fundamental physical and chemical science of combustion phenomena.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Discuss the fundamental and characteristic physical and chemical features of simple flames and combustion processes.
2. Balance chemical reactions, calculate product composition, and estimate the adiabatic flame temperature and equilibrium composition of major combustion products.
3. Determine the approximate rate of a combustion reaction from global kinetic data, and estimate the rate of reactions in well-stirred flow and batch chemical reactors.
4. Describe the major elementary reactions and reaction mechanisms of hydrogen and hydrocarbon combustion.
5. Discuss the important diffusion, convection, and generation terms in the equations of mass, momentum, energy and species conservation, for combustion processes.
6. Describe the major features of premixed combustion, detonation and deflagration modes, laminar and turbulent premixed flames.
7. Explain the thermal model of laminar premixed flame propagation, ignition and flammability limits, and estimate the flame velocity and thickness.
8. Apply the concept of mixture fraction to describe one-dimensional non-premixed diffusion flames.
9. Describe the features of laminar and turbulent non-premixed jet flames, and liquid droplet and solid fuel combustion.
10. Independently review a specialized topic in combustion, or apply combustion knowledge to understand practical combustion devices such as engines and furnaces.
11. Describe the types of pollutants generated in typical combustion processes and the available control techniques, and report emissions rates in appropriate units.

C. Subject Matter:
Unit I:
Energy sources: Energy scenario, review of general fuel properties & their resources in Indian context, solid, liquid & gaseous fuels.

Unit II:

Unit III:
Theories of combustion: Burners & Combustors for solid, liquid & gaseous fuels, Fuel chemistry, Thermodynamics of combustion, calculation of temperature and equilibrium flame gas composition for constant pressure and constant volume combustion.

Unit IV:

D. Learning/Practice Pattern:

Teaching: 70 %
Learning: 30 %
Practice: 0 %

E. Examination Pattern:

1. Theoretical Examination.

F. Reading List:
Books:
1. S. P. Sharma & C. Mohan, “Fuels and combustions”, TMGH.
5. S. R. Turns, “Combustion”, MGH.

Magazine:
1. Model Engine Builder.
2. Car and Driver.
4. ES Engineered Systems.

Journals:
Name of the Module: Computational Fluid Dynamics

Module Code: ME 703/2
Semester: 7th
Credit Value: 3\(P=0, T=0, L=3\)

Module Leader:

A. Objectives:
The course is design to meet with the following objectives:

1. To introduce the student to the basics of computational fluid dynamics (CFD). The main focus will be on the use of finite difference methods for numerical integration of partial differential equations and governing equations of fluid dynamics and heat transfer will be introduced and considered. One main theme will be the accuracy and stability of the numerical schemes employed for the solution of CFD problems. Explicit and implicit schemes will be studied.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Derive the Navier stokes equations.
2. Distinguish the properties of partial differential equations for compressible and incompressible flows.
3. Determine the accuracy of a difference algorithm.
4. Determine the stability of a difference algorithm.
5. Develop a computer code to study the accuracy and stability of an algorithm for an incompressible flow problem.
6. Develop a computer code to study the accuracy and stability of an algorithm for a compressible flow problem.
7. Evaluate an accuracy and stability of a given algorithm.
8. Review a technical paper describing a specific algorithm.

C. Subject Matter:
Unit I:

Introduction: CFD as a design and research tool, Applications and impact of CFD; Concepts of finite control volume & infinitesimal fluid elements, analysis with fixed and moving fluid elements, Substantial derivative, Divergence of velocity – its physical significance,

Unit II:

Governing Equations: Derivation of Continuity equations for different flow models, conversion from one form of continuity equation to other forms, Differential form Vs. integral form, Momentum equation, Energy equation, Forms of equations for viscous and inviscid flows, Boundary conditions, Conservation and non conservation forms, Forms of equations suited for CFD, Shock fitting and shock capturing

Partial Differential Equations And Descretisation: Classification of PDEs, method of determining the type of PDEs, General behavior of PDEs, Hyperbolic, Parabolic and Elliptic equations, Well posed
and ill-posed problems; Finite difference techniques, Difference equation, Explicit and Implicit Approaches, Errors in difference equations, Stability analysis.

**Unit III:**

**Introduction to Grid Generation:** Transformations of equations, Metrics and Jacobians, Transformed versions of governing equations, Stretched grid and Boundary fitted coordinate system

**Simple CFD Techniques:** Crank-Nicolson scheme, Dufort-Frankel scheme, Lax-Wendroff and Mac Cormack techniques, Viscous flows, Conservation form and space marching, Relaxation technique, artificial viscosity, application in inviscid flows, Vorticity transport method; ADI (Alternating Direction Implicit) technique, Pressure correction technique, SIMPLE algorithm; Programming in FORTRAN/ C/ C++

**Unit IV:**

**Applications:** Finite difference method to solve WAVE equation, HEAT equation, POISSON & LAPLACE equations, BURGER equation. Numerical methods applied to nozzle flow, Coutte Flow; Prandtl-Meyer flow and supersonic flow over flat plates; Programming in FORTRAN/ C/ C++; CFD Softwares.

**D. Teaching/Learning/Practice Pattern:**

- Teaching: 70 %
- Learning: 30 %
- Practice: 0 %

*(Teacher is to divide components for T/R/P)*

**E. Examination Pattern:**

1. Theoretical Examination

**F. Reading List:**

**Books:**

1. J. D. Anderson, Jr., “Computational Fluid Dynamics”, MGH
4. Anit W. Date, “Introduction to Computational Fluid Dynamics”, Cambridge University Press

**Magazine:**

1. The CFD Magazine.

**Journals:**

1. *Engineering Applications of Computational Fluid Mechanics.*

Name of the Module: Aerodynamics  
Module Code: ME 703/3  
Semester: 7th  
Credit Value: 3[P=0, T=0, L=3]  
Module Leader:

A. Objectives:

   The course is designed to meet with the following objectives:

   1. Perform a range of analytical tasks appropriate to engineering as a whole.
   2. Demonstrate appropriate understanding of key scientific and other concepts underpinning engineering as a whole.
   3. Utilise mathematics, computational tools and techniques.
   4. Plan experimental investigations, and select and use sound experimental techniques, and validly interpret experimental data.

B. Learning Outcome:

   Upon completion of the subject, students will be able to:

   1. Demonstrate understanding of fundamental principles in theoretical and applied aerodynamics.
   2. Demonstrate ability to apply these principles in the analysis of essential aerodynamic behaviour relevant to typical practical applications, specifically.
   3. Demonstrate ability to analyse aircraft longitudinal stability and control, and aircraft lateral stability and control.
   4. Demonstrate ability to describe and analyse (using both mathematical analysis and numerical analysis) the aerodynamic behaviour of finite wings.
   5. Demonstrate ability to estimate propeller performance using momentum and blade element theories and performance charts; and extend this to analysis of the performance of a helicopter in hovering and axial flight.
   6. Demonstrate ability to analyse compressible flows and through this demonstrate understanding of supersonic and transonic aerodynamics.

C. Subject Matter:

   Unit I:  
   Introduction: Governing equations, potential flows, Kulta-Joukowski’s theorem, flow over arbitrary bodies. Incompressible flow over aerofoils: Aerofoil nomenclature and characteristics, Thin Aerofoil theorem- Kutta condition, Kelvin’s circulation theorem

   Unit II:
Vortex panel model: effect of camber and thickness; Estimation of Aerodynamic forces and moments from pressure distribution.

Unit III:
Incompressible flow over finite wings: Down wash and induced drag, Biot-Savart law and Helmholtz’s Vortex theorem. Prandtl’s classical lifting line model, lifting surface theory.

Unit IV:
Trailing edge boundary condition: Prandtl-Glaurt’s theory, Supersonics aerofoils, Ackert’s theorem, Wave drag, Area rule, conical flow, Axisymmetric flow, Introduction to stability Control of aircraft.
Numerical Vortex Lattice method, Compressible flow over aerofoils, Wave patterns, Oblique shock, and expansion waves.

D. Teaching/Learning/Practice Pattern:
Teaching: 70 %
Learning: 30 %
Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:
1. Theoretical Examination.

F. Reading List:
Books:
1. J. D. Anderson Jr., “Fundamentals of Aerodynamics”, MGH
5. W. F. Durrand, “Aerodynamics theory”, PHI

Magazine:
1. Pedal Power, University of Maryland.
2. The Power of 25.

Journals:
1. International Journal of Aerodynamics.
5. Journal of Aerospace Engineering, American Society of Civil Engineers, ASCE.
6. *Journal of Aircraft, American Institute of Aeronautics and Astronautics Inc. AIAA.*

**Name of the Module: Prime Mover Design**  
**Module Code: ME 703/4**  
**Semester: 7th**  
**Credit Value: 3[P=0, T=0, L=3]**  
**Module Leader:**

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**A. Objectives:**  
The course is designed to meet with the following objectives:

1. This course will introduce basic ideas of turbomachinery and the basic equations that govern the performance of turbomachinery. The introductory course aims at teaching the students in cycle analysis, efficiency calculation, and flow and energy analysis.

**B. Learning Outcome:**  
Upon completion of the subject, students will be able to:

1. Give precise definition of turbomachinery.
2. Identify various types of turbomachinery.
3. Perform thermal cycle analysis on gas-turbine engines.
5. Apply the Euler's equation for turbomachinery to analyze energy transfer in turbomachines.
6. Apply three-dimensional velocity diagrams to turbomachine analysis.
7. Design axial-flow turbines and compressors.
8. Design radial-flow turbomachines.
9. Compute efficiencies of various turbomachines.

**C. Subject Matter:**

**Unit I:**  
**Thermodynamic design of Steam and Gas Turbines:** Selection of type, no. of stages and heat drops, Design of blade geometry, Design of nozzles & diaphragms.

**Unit II:**  
**Design of casings:** Design of packing and seals, Shaft design Selection of bearing, Governing system, Cooling system and lubrication system.

**Unit III:**  
**Specific speed and Selection of Hydraulic turbines:** Velocity triangles and blade geometry, Volute casing Design, Governing system, Draft tubes.

**Unit IV:**  
**IC engine design aspects:** Design of cylinder and ports, Fuel injection system, Engine Governing system.
D. Teaching/Learning/Practice Pattern:

Teaching: 70 %
Learning: 30 %
Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

1. Theoretical Examination

F. Reading List:

Books:
1. *Steam Turbine Theory & Practice* – W. J. Kearton

Magazine:
1. *Prime mover Design, Volvo optimized service plan.*
2. *Prime mover Design.*

Journals:
1. *Journal of Engineering for Gas Turbines and Power*
2. *Journal of Terramechanics*
3. *Journal of Mechanisms and Robotics*
Name of the Module: Compressible Flow
Module Code: ME 703/5
Semester: 7th
Credit Value: 3\([P=0, T=0, L=3]\]
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:

1. Provide the theoretical background and problem-solving skills needed to successfully analyse basic compressible flows and acoustic problems.
2. Build a sound foundation for studies of more complex compressible-flow phenomena.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Determine if the theory of ideal compressible fluid flow is applicable for any given real flow and formulate the mathematical model of compressible fluid flow including the initial and boundary conditions, for solving it numerically or analytically.
2. Demonstrate good understanding of the theoretical bases of the method of characteristics for ideal potential flow.
3. Apply method of characteristic to two-dimensional supersonic nozzle design.
4. Obtain knowledge on fundamental acoustics, wave equation and wave propagation.
5. Understand flow generated noise, its propagation and sources in compressible flow.
6. Formulate aero acoustic problems for solving it numerically or analytically based on knowledge of aero acoustic theory and available solution methods.

C. Subject Matter:
Unit I:
Review of Fluid dynamics and thermodynamics principles and concepts: Generalised energy equation, Energy equation for compressible flow; Compressibility correction factor; Stagnation and Critical state parameters.

Unit II:
Isentropic flow with area change; subsonic & supersonic nozzle & diffuser: Nozzle operation, Nozzle choking, Overexpansion & under expansion Normal shock analysis, Hugoniot equation, Oblique shock-tangential velocity superposition on normal shock, oblique shock analysis, Shock strength, Weak & strong shocks, Attached & detached shocks, Pressure and entropy changes across a Mach wave.

Unit III:
Isentropic turn of supersonic flow: Prandtl Meyer flow, Expansion fans and compression waves Effects of friction on compressible flow (Fanno flow), Effect of heat transfer (Rayleigh flow), flow choking, combined effect of friction and heat transfer, Compressible flow measurement: Supersonic wind tunnels.

Unit IV:
Flight speed measurement: Optical techniques, Schlieren Technique and Interferometer, Computational methods in compressible flow.
D. Teaching/Learning/Practice Pattern:

- Teaching: 70%
- Learning: 30%
- Practice: 0%

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

1. Theoretical Examination

F. Reading List:

Books:
2. E. Rathakrishnan, “Gas Dynamics”, PHI
5. J. Anderson, “Modern Compressible Flow: With Historical Perspective”.

Magazine:
1. Large eddy simulation for compressible flow by E. Garnier.

Journals:
1. Journal of Fluid Mechanics
2. Journal of Turbulence
3. Journal of Fluids Engineering
4. Journal of Applied Mathematics

Name of the Module: High Pressure Equipment Design

Module Code: ME 703/6

Semester: 7th

Credit Value: 3\{P=0, T=0, L=3\}

Module Leader:

A. Objectives:
The course is design to meet with the following objectives:
1. To be able to apply the requirements of the relevant industry standards to the mechanical design of equipments used in the process industry and above ground atmospheric storage.
2. To specify appropriate physical property models to simulate processes.
B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Identify the elements of the design process.
2. Identify or define the yield stress and the ultimate stress of a material.
3. Calculate the endurance limit of a material with appropriate corrections.
4. Identify the stresses acting on a surface and find principal stresses.
5. Evaluate loading and stress results using principal shear stress criterion.
6. Evaluate loading and stress results using maximum distortion energy criterion.
7. Create a Soderberg endurance failure line.
8. Calculate stresses and loads involved with fatigue effect.
9. Devise a list of concepts for a design application using idea-generation techniques.
10. Determine the stresses in a gear using the Lewis equation or the AGMA equation.
11. Calculate the life of ball or roller bearings.
12. Determine shaft parameters so that design conditions for performance are met.
13. Calculate bounds on parameters in design.

C. Subject Matter:
Unit I:
Design Considerations: Preliminary considerations, Design construction and features, Stress analysis of components shells. Thick and thin shells.

Unit II:
Ends, flanges, local attachments, etc.

Unit III:
Material selection, Special type of vessels-high pressure applications.

Unit IV:
Externally loaded vessels, etc. Design system, Use of Codes.

D. Teaching/Learning/Practice Pattern:
Teaching: 70 %
Learning: 30 %
Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:
1. Theoretical Examination

F. Reading List:
Books:
1. Van Nostand, Pressure vessel Design, MGH.
2. M. V. Joshi, Process equipment design, McMillan India.
3. Material Handling equipment Hand book, MGH.

Magazine:

Journals:
2. International Journal for Engineering Modelling, University of Split.
3. Advances in Modelling and Analysis A, ASME.
4. Advances in Modelling and Analysis B, ASME.
5. Journal of Ergonomics
6. An International Journal for Fusion Energy and Technology devoted to Experiments, Theory, Methods and Design
7. Journal of Engineering, Design and Technology
8. Journal of Mechanical Design

Name of the Module: Two Phase Flow and Heat Transfer
Module Code: ME 703/7
Semester: 7th
Credit Value: 3 [P=0, T=0, L=3]
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:
1. Analyse heat conduction using Fourier’s Law.
2. Analyse convective heat transfer.
3. Analyse unsteady convective heat transfer.
4. Analyse radiation heat transfer.
5. Solve the heat diffusion equation.
6. Evaluate thermal resistances.
7. Determine overall heat transfers coefficients.
8. Design double pipe heat exchangers.
10. Determine heat transfer from fins.
11. Analyse one-dimensional unsteady state heat transfer.
12. Utilize heat transfer coefficient correlations.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Understand the basic laws of heat transfer.
2. Account for the consequence of heat transfer in thermal analyses of engineering systems.
3. Analyse problems involving steady state heat conduction in simple geometries.
5. Obtain numerical solutions for conduction and radiation heat transfer problems.
6. Understand the fundamentals of convective heat transfer process.
7. Evaluate heat transfer coefficients for natural convection.
8. Evaluate heat transfer coefficients for forced convection inside ducts.
9. Evaluate heat transfer coefficients for forced convection over exterior surfaces.
10. Analyse heat exchanger performance by using the method of log mean temperature difference.

C. Subject Matter:
Unit I:

Unit II:
Flow pattern and material handling: Flow pattern maps for horizontal and vertical system, Material handling: solid-liquid and solid-gas system, Particle distribution, Pressure variation, Simplified treatment of stratified, bubbly, slug and annular flows.

Unit III:
Condensation: Film and drop wise condensation.

Unit IV:
Fluidized bed heat transfer

D. Teaching/Learning/Practice Pattern:
Teaching: 70 %
Learning: 30 %
Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:
1. Theoretical Examination

F. Reading List:
Books:
1. G. B. Wallis, One dimensional two phase flow, MGH.

Magazine:
2. LMS Imagine. Lab Two-Phase Flow Systems.

Journals:
2. International Communications in Heat and Mass Transfer, Elsevier Ltd.

Name of the Module: Management of Production System
Module Code: ME 703/8
Semester: 7th
Credit Value: 3\[P=0, T=0, L=3\]
Module Leader:

A. Objectives:
The course is designed to meet the following objectives:
1. Competently employ broad-based analytical tools and computers for decision-making and system design, analysis, and performance.
2. Assume managerial and leadership roles in their chosen professional careers while working in multidisciplinary teams.
3. Engage in continuous learning by seeking out opportunities for higher education or ongoing training related to their employment.
4. Effectively adapt to the changing demands in workplace and are able to perform increasingly complex tasks, and tasks outside their field of expertise.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
2. Design and conduct experiments, as well as to analyse and interpret data.
3. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. Function on multi-disciplinary teams.
5. Identify, formulate, and solve engineering problems.
6. Understand the professional and ethical responsibility.
7. Communicate effectively.
8. Have broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
9. Recognize the need for, and an ability to engage in life-long learning.
10. Have knowledge of contemporary issues.
11. Use the techniques, skills, and modern engineering tools necessary for engineering practice.
C. Subject Matter:

Unit I:

Types of Production: Job, Batch, Mass, Cellular production systems, automation in production systems, MTL and its mathematical models, material handling.

Unit II:

AGVS, TTW, Productivity Engineering: methods of improvement, cost analysis, marketing and sales, Inventory, production planning and control, Automated layout and flow analysis, systems concepts in production systems CAD, CIM.

Unit III:

Shop floor management techniques: Job card design, work centres, work study, time study applications.

Unit IV:

Quality circles, productivity quality teams: work force planning, TQM, ISO 9000, Future factories and MAP, Group technology and FMS.

D. Teaching/Learning/Practice Pattern:

Teaching: 70 %
Learning: 30 %
Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

1. Theoretical Examination

F. Reading List:

Books:

Magazine:

Journals:
3. Production Planning and Control, Taylor and Francis Ltd.
Elective II

Name of the Module: Fluid Power Control Systems
Module Code: ME 704/1
Semester: 7th
Credit Value: 3\[P=0, T=0, L=3\]
Module Leader:

A. Objectives:
The course is designed to meet the following objectives:

1. An easy means of multiplying and controlling force and torque.
2. Infinitely variable speed control for both linear and rotary motion.
3. Overloading the system simply stalls the actuator without damage to the components.
4. Provide easy means of accurately controlling the speed of machines and/or machine parts.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Define the terms fluid power, hydraulic system, and pneumatic system.
2. Explain the extent of fluid power use in current society and provide several specific examples.
3. List the advantages and disadvantages of fluid power systems.

C. Subject Matter:

Unit I:

Source of hydraulic power: Positive displacement pumps, types, classifications, construction and operation of Gear, Vane (Constant, variable delivery and pressure compensated) and Piston pumps (Inline and radial type), Efficiency calculation, Pump selection, Pump performance.

Fluid power actuators: Linear, single acting, double acting and telescopic, Cylinder force, velocity and power, Cylinder cushioning devices, Cylinder mountings, Rotary or Hydraulic motors, Types – gear, vane and piston types Torque, power, flow rate and efficiencies, Hydrostatic transmissions.

Unit II:
Control components in hydraulic system: (i) Flow control valves: needle, pressure and temperature compensated valves; (ii) Pressure control valves: Relief – direct, compound & pilot operated, pressure -reducing, sequence valve; (iii) Direction control valve: check valve, two way - two position, four way - three position, four way -two positions valves. Centre flow path configuration of 3 position d.c. valves: open centre, close centre, tandem centre; Cartridge valves; Manually operated - solenoid operated valves; Servo valves; Proportional control valves.

Unit III:
Hydraulic circuit design and analysis: Symbols for hydraulic and pneumatic circuits; Speed control circuits such as Meter-in, Meter-out, Bleed-off, and Regenerative circuits, Unloading circuit, Counter
balance circuit, Cylinder synchronization, Accumulator circuits, and Fail safe circuits; Trouble shooting of hydraulic circuits.

D. Teaching/Learning/Practice Pattern:

  Teaching: 70 %  
  Learning: 30 %  
  Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

  1. Theoretical Examination

F. Reading List:

Books:
  1. Anthony Espositio, Fluid Power with applications, PHI.
  3. S. R. Majumdar, Oil Hydraulics (Principles and Maintenance), TMH.
  4. Yeaple Frankline, Hydraulic and Pneumatic power & Control.
  5. S. R. Majumdar, Pneumatic system, TMH.
  6. A. B. Goodwin, Fluid power system.

Magazine:

Journals:
  5. Journal of Dynamic Systems, Measurement and Control
  6. Journal of Fluids Engineering
Name of the Module: Composite Materials
Module Code: ME 704/2
Semester: 7th
Credit Value: 3\(P=0, T=0, L=3\)
Module Leader:

A. Objectives:
The course is designed to meet the following objectives:

1. To teach students the basic concepts involved in fiber reinforced composites and their applications in engineering.
2. The objective for this course is to develop an understanding of the linear elastic analysis of composite materials. This understanding will include concepts such as anisotropic material behaviour and the analysis of laminated plates. The students will undertake a design project involving application of fibre reinforced laminates.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Explain the concept of composite materials.
2. Differentiate metallic versus composite materials.
3. Compare the mechanical properties of composite materials to the metallic materials.
4. Predict the composite properties at micro-level.
5. Explain different manufacturing techniques for composites.
6. Analyze fiber-reinforced composites for stresses and deformations.
7. Design composite members for stiffness and strength.
8. Predict failure in composite members.
9. Work in a group or individual setting and write a report.
10. Explain the advantages of composites over metals.

C. Subject Matter:
Unit I:

Introduction: materials, fibre reinforcement, matrix materials.

Manufacturing processes: hand lay-up, prepeg lay-up, bag molding, autoclave processing, compression molding, resin transfer molding, pultrusion, filament winding.

Unit II:


Unit III:

Macro-mechanics: description of laminates, laminate moduli, computation of stresses in laminates,

Unit IV:

Types of joints, Mechanics of joints: Damages in joints.
Failure criteria: Strength of materials approaches, Fracture mechanics approach.

D. Teaching/Learning/Practice Pattern:

Teaching: 70 %
Learning: 30 %
Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

1. Theoretical Examination

F. Reading List:

Books:
2. S. W. Tsai, Mechanics of Composite Materials, MGH.

Magazine:
1. Polymer Composites, Macro- and Micro composites.

Journals:
Name of the Module: Turbomachines
Module Code: ME 704/3
Semester: 7th
Credit Value: 3\(P=0, L=3, T=0\)
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. This course will introduce basic ideas of turbo machinery and the basic equations that govern the performance of turbomachinery.
2. It also aims at teaching the students in cycle analysis, efficiency calculation, and flow and energy analysis.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Give precise definition of turbo machinery.
2. Identify various types of turbo machinery.
3. Perform thermal cycle analysis on gas-turbine engines.
5. Apply the Euler's equation for turbo machinery to analyze energy transfer in turbo machines.
6. Apply three-dimensional velocity diagrams to turbo machine analysis.
7. Design axial-flow turbines and compressors.
9. Compute efficiencies of various turbo machines.

C. Subject Matter:
Unit I:
    \textbf{Introduction} : Dimensional analysis & similitude, Performance laws, incompressible flow analysis, performance characteristics, variable geometry turbo machines (axial, radial & mixed flow machines), specific speed & cavitation, compressible gas flow relations and compressible fluid analysis, inherent unsteadiness of flow within turbomachines.

Unit II:
    \textbf{Two dimensional Cascades} : Cascade nomenclature & geometry, Analysis of cascade forces, energy losses, lift & drag, circulation and lift, efficiency of compressor cascades, performance of two-dimensional cascades, cascade wind tunnel & instrumentation, cascade test results, compressor cascade correlations, turbine cascade correlation, comparison of profile loss in a cascade and in a turbine stage, optimum space-chord ratio.

Unit III:
    \textbf{Axial flow turbines} : Two dimensional theory, Velocity diagrams, stage losses and efficiency, stage reaction, diffusion within blade rows, design point efficiency, max, total-to-static efficiency of a reversible turbine stage.
    \textbf{Axial flow compressors and fans} : 2-D analysis, velocity diagram & thermodynamics of compressor stage, stage losses & efficiency, reaction ratio & stage loading, Off-design performance, stage
pressure rise, pressure ratio in a multistage compressor, estimation of compressor stage efficiency, Axial flow ducted fans, Blade element theory.

**Unit IV:**

**Radial Flow Turbine:** Losses & efficiencies, work & power calculations, velocity triangles & thermal design. Types of inward flow radial turbines, thermodynamics of IFR turbines, rotor design, nominal design point efficiency, loss coefficients, incidence losses, clearance & windage losses, significance & application of specific speed.

**Centrifugal pumps, fans & compressors:** Some definitions, theoretical analysis, Inlet casing and impeller, conservation of rothalpy, diffuser, limitation of inlet velocity, optimum design of pump & compressor inlet, slip factor, performance characteristics, choking in a compressor stage.

**D. Teaching/Learning/Practice Pattern:**

- Teaching: 70%
- Learning: 30%
- Practice: 0%

*(Teacher is to divide components for T/R/P)*

**E. Examination Pattern:**

1. Theoretical Examination

**F. Reading List:**

**Books:**

2. Cherkasky, *Pumps, fans and compressors*.
3. S. M. Yahya and Satya Prakashan, *Turbines, fans and compressors*.
6. V. Ganeshan, *Gas Turbines*.

**Magazine:**


**Journals:**

Name of the Module: Computer Aided Design and Graphics
Module Code: ME 704/4
Semester: 7th
Credit Value: 3[P=0, L=3, T=0]
Module Leader:

A. Objectives:
The course is designed to meet the following objectives:
1. Explain how computer technology is revolutionizing drafting, design, and engineering.
2. Describe the basic features and operation of a computer-aided drafting program.
3. Explain the various commands used to create objects in CAD.
4. Describe the tools used to modify CAD drawings.
5. Identify the various display functions used in CAD programs.
6. Describe the typical components in a CAD program Help system.
7. Explain the importance of CAD file management and identify common storage techniques.
8. List different types of CAD software and their applications.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Derive and manually solve finite element problems consisting of one-dimensional structural elements.
2. Use the finite element method for stress analysis and design of structures in multi-dimensions.
3. Use the finite element method for heat transfer analysis of solids in multi-dimensions.
4. Use a commercial finite element code competently for analysis and design problems.
5. Create geometry and finite element meshes for 2D and 3D complex systems.
6. Make checks to verify and evaluate the accuracy of finite element solutions.
7. Write good project reports describing and evaluating the obtained results.
8. Give good oral presentations of projects.

C. Subject Matter:
Unit I:
Computer Technology: Introduction, CPU, memory, input, output, data representation, programming languages (Machine/assembly/HLL).

Unit II:
Design Process: General design process, computer application for design and introduction of FEM (1-D elastic problems, pre and post processing.

Unit III:
Geometrical Modeling: Defining the model, technique for geometrical modeling (wire frame/surface/solid), entity manipulation and data storage, Standards for CAD, elements of interactive computer graphics (ICG), Applying CAD model in design.

Unit IV:
Drawing Algorithms, Transformations: Line and circle drawing algorithm, transformation (2D and 3D), character generator, windowing & clipping, Splines and Bazier curves.

Expanding the capability of CAD: Introduction, A.I in design (expert/knowledge based system), Parametric and variation modeling, feature based modeling, design information systems.

D. Teaching/Learning/Practice Pattern:

    Teaching: 70 %
    Learning: 30 %
    Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

    1. Theoretical Examination

F. Reading List:

Books:
   2. Ibrahim Zied, Computer Aided Design, MGH.
   3. Groover & Zimmers,Jr, CAD/CAM (Computer Aided Design and Manufacturing), PHI.
   4. Hern and Baker, Computer graphics, PHI.

Magazine:

Journals:
   2. Cad Computer Aided Design, Elsevier Ltd
Name of the Module: Finite Element Methods  
Module Code: ME 704/5  
Semester: 7th  
Credit Value: 3[P=0, L=3, T=0]  
Module Leader:  

A. Objectives:  
The course is designed to meet with the following objectives:  
1. To teach students the finite element method  
2. To convey the basic ideas on which the method is founded.  
3. The basic principles of the method with applications in several areas  
4. To apply the method to problems of their individual interests. A multi-physics finite element code, ANSYS is used for applications.  

B. Learning Outcome:  
Upon completion of the subject, students will be able to:  
1. Derive the finite element equations for different boundary- and initial-boundary-value problems.  
2. Use partial-differential equation concepts, variational principles, and interpolation theories to derive finite element model.  
3. Develop finite element algorithms for steady and transient problems.  
4. Use finite element codes for modeling of problems encountered in various branches of engineering and sciences.  
5. Analyze and evaluate the solution of finite element codes. Make error analysis and checks to verify accuracy of the finite element solutions.  
6. Code finite element programs with minimum extra training.  
7. Apply the method to problems in their specific field of study.  

C. Subject Matter:  
Unit I:  
**Introduction:** Fundamental concepts of finite element methods, direct equilibrium method, work or energy method, method of weighted residuals, variational principles, interpolation and shape function, general formulae for element matrices, nodal loads produced by traction and body force.  

Unit II:  
**One dimensional finite element analysis:** linear spring/ plane stress/ space truss (axial displacement), 1 D torsion (torsional rotation), 1 D heat conduction (temperature), 1 D seepage (fluid potential), FE based on displacement field.  
**Two - Dimensional finite element analysis (using CST):** 2- D stress analysis, 2-D confined seepage analysis, applications of 3-D equations for 2-D analysis (Axi-symmetric situation).  
**Two-dimensional iso-parametric elements and numerical integration:** introduction, four node, quadrilaterals, higher order elements.  
**Beams:** Formulation, load vector, boundary considerations, shear force and bending moment.  

Unit III:
Computer implementation of FEM: use of symmetry and anti-symmetry conditions in reducing a problem, static condensations, storage scheme for global stiffness matrix, application of boundary condition.

D. Teaching/Learning/Practice Pattern:

- Teaching: 70%
- Learning: 30%
- Practice: 0%

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

1. Theoretical Examination

F. Reading List:

Books:
4. K. J. Bathe, “Finite Elements procedures”, PHI.
5. O. C. Eienkiewicg and K. Morgan, “Finite Elements Approximations”, MGH.

Journals:
Name of the Module: Non Conventional Energy
Module Code: ME 704/6
Semester: 7th
Credit Value: 3\{P=0, T=0, L=3\}
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:

1. Students will learn the fundamental principles of the various renewable energy options and their applications and costs.
2. Students will be familiar with the basic technical details of various renewable energy systems, be able to contribute to the design or selection of renewable energy systems, and be able to estimate the amount of energy available from the renewable energy resource, the efficiency and power output of renewable energy systems, and their benefits and costs.
3. The course will provide hands-on experience related to fuel cell and battery technology.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Understand the scope and options for renewable energy.
2. Evaluate various energy resources, including their energy value and environmental and economic impacts.
3. Select and preliminary design of various energy systems.
4. Have working knowledge of each of the renewable energy sources covered in lectures.

C. Subject Matter:
Unit I:
Non-conventional Energy sources: General introduction to non-conventional energy source and systems.
Solar radiation: measurement, collection, storage, and applications.

Unit II:
Wind energy: Potential evaluation.
Types of wind machines: Horizontal and vertical axis wind rotors performance, Generating systems, applications.

Unit III:
Design and evaluation of wind mills: Wind regime analysis.
Bio-mass: Recycling of agricultural wastes, Conversion technologies, types, Digester.

Unit IV:
Other Technologies: MHD, Thermoelectric, Thermionic, thermo nuclear fusion technology.
D. Teaching/Learning/Practice Pattern:
   Teaching: 70 %
   Learning: 30 %
   Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:
   1. Theoretical Examination

F. Reading List:
   Books:
   1. Black & Vealch, “Power Plant Engineering”, MGH.
   6. P. K. Nag, “Power Plant Engineering”, TMGH.

   Magazine:
   1. Non-Conventional Energy Resources.
   2. Limitations of Conventional Sources of Energy.

   Journals:
   2. Development of Non-Conventional Energy Sources, Indian Institute of Technology, India Moradabad Institute of Technology, India.
Name of the Module: Principles of Tribology
Module Code: ME 704/7
Semester: 7th
Credit Value: 3\{P=0, T=0, L=3\}
Module Leader:

A. Objectives:
The course is designed to meet the following objectives:

1. Describe surface topography, physico-chemical aspects of solid surfaces, and surface interactions.
2. Analyse the mechanics of solid elastic and elastoplastic contacts.
3. Recognize the laws of friction, mechanisms of friction, friction space, stiction, stick slip, and surface temperature.
4. Appreciate the various modes of wear: adhesive, delamination, fretting, abrasive, erosive, corrosive, oxidative (mild and severe), melt, and the wear-mechanism maps.
5. Identify types of lubrication: boundary, solid-film, hydrodynamic, and hydrostatic lubrication.
6. Examine applications/case studies: sliding contacts, rolling contacts, bearing design, coating selection, and lubrication.
7. Explore the design of tribological surfaces and how to troubleshoot tribology problems.
8. Survey tribological testing devices and testing design.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Identify critical parameters in a tribological system.
2. Make predictions of the performance and behaviour of a tribological system based on these critical parameters.
3. Design or choose efficient and robust tribological systems such as rolling element bearings, hydrodynamic bearings and dry sliding bearings, for the needs of a specific application.
4. Improve the tribological properties of a machine component surface to improve reliability.
5. Optimize existing and new systems to improve performance.

C. Subject Matter
Unit I:
Friction: Introduction, Modes of friction, dry friction.

Unit II:
Lubrication: Boundary lubrication, hydrodynamics and hydrostatic lubrication, Elastic hydrodynamics lubrication, design characteristics of slider bearings.

Unit III:
Bearings: Operating characteristics of slider bearings, wears types and characteristics, Selection of rolling elements bearing and their operating parameters.

Unit IV:
Industrial lubricants: Oils, Grease, solids and special lubricants, bearing failures, bearing maintenance, diagnostic maintenance of tribology components.
D. Teaching/Learning/Practice Pattern:

Teaching: 70 %
Learning: 30 %
Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

1. Theoretical Examination

F. Reading List:

Books:
2. O. Pinkus and B. Sternicht, “Theory of hydrodynamic lubrication”, MGH.

Magazine:
1. Tribology & Lubrication Technology, Society of Tribologists and Lubrication Engineers.

Journals:
2. Tribologia, Helsinki University of Technology.
3. Tribology - Materials Surfaces and Interfaces, Maney Publishing.
Name of the Module: Aerospace Propulsion
Module Code: ME 704/8
Semester: 7th
Credit Value: 3\( [P=0, T=0, L=3] \)
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:

1. The objectives of this course are to develop an understanding of how air-breathing engines and chemical rockets produce thrust.
2. Ability to do overall engine performance analysis calculations.
3. Ability to carry out performance calculations for individual engine components.
4. Ability to carry out performance analysis for chemical rockets.
5. Understanding of elementary overall engine design considerations.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Understand quasi-one-dimensional flow.
2. Understand the generation of thrust in air-breathing engines and rockets.
4. Carry out overall performance calculations of turbojets, turbfans and turboprops.
5. Understand combustors, afterburners, and exhaust nozzles.
6. Understand the axial flow compressors and turbines, and an ability to carry out flow and performance calculations for these.
7. Carry out simple flight performance calculations for rockets.
8. Understand the fundamentals of chemical rocket performance.
9. Understand how liquid and solid propellant rockets work.

C. Subject Matter:
Unit I:
Air-breathing and non air-breathing engines, Piston engine and gas turbine engine cycles, ideal and real thermodynamic cycle analysis.

Unit II:
Components performance intake, combustor, nozzle, turbomachinery, etc., Turbojet, turboprop, turbfan engines, ramjet, scramjet and pulsejet, Performance parameters like thrust propulsive efficiency, etc.

Unit III:
Chemical Rockets, Propellant types, properties, injectors, thrust chamber, burning rate, cryogenic propellant, combustion phenomena.

Unit IV:
Thrust vector control, ignition and inhibitors, Basic concept of Electrical and Nuclear rockets.
D. Teaching/Learning/Practice Pattern:

   Teaching: 70 %
   Learning: 30 %
   Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

   1. Theoretical Examination.

F. Reading List:

   Books:

   Magazine:
   1. Pedal Power, University of Maryland.
   2. The Power of 25.

   Journals:
Name of the Module: Theory of Elasticity
Module Code: ME 704/9
Semester: 7th
Credit Value: 3\{P=0, T=0, L=3\}
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:

1. To establish an understanding of the fundamental concepts of mechanics of deformable solids, including static equilibrium, geometry of deformation, and material constitutive behaviour.
2. To provide students with exposure to the systematic methods for solving engineering problems in solid mechanics.
3. To discuss the basic mechanical principles underlying modern approaches for design of various types of structural members subjected to axial load, torsion, bending, transverse shear, and combined loading.
4. To build the necessary theoretical background for further structural analysis and design courses.

B. Learning Outcome:
Upon completion of the subject, students will be able to:

1. Understand the concepts and principles applied to members under various loadings and the effects of these loadings.
2. Analyse and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behaviour of materials.
3. Analyse columns and pressure vessels under various loadings.

C. Subject Matter:
Unit I:
Introduction: Elasticity, stress, components of stresses, components of strains, generalised law. Plane Stress and Plane Strain: plane stress and plane strain, stress at a point, strain at a point, differential equation of equilibrium, boundary condition stress function. 2D Problems in Rectangular Co-ordinates

Unit II:
Solution by polynomial, stvenant’s principle, determination of displacement, bending of cantilevers loaded at the ends, bending of beams by uniform loads etc.

Unit III:
2D Problems in Polar Co-ordinates: general equation in polar co-ordinates, stress distribution, symmetrical about an axis. Pure bending of curve bars, strain components in polar coordinates, Displacement for symmetrical stress distribution, rotating disks, bending of a curved bar by a force at the end.

Unit IV:
Photoelasticity: Experimental method and verification, circular polariscope, photo elastic stress-distribution, determination of principle stresses, 3-dimensional photoelasticity.
D. Teaching/Learning/Practice Pattern:

Teaching: 70 %
Learning: 30 %
Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:

1. Theoretical Examination

F. Reading List:

Books:
1. Timoshenko and Goodier, “Theory of elasticity”, MGH.
2. Dally and Riley, “Experimental Stress Analysis”, MGH.

Magazine:
2. Everyday Engineering Magazine.

Journals:
Name of the Module: Boundary Layer Theory
Module Code: ME 704/10
Semester: 7th
Credit Value: 3[P=0, L=3, T=0]
Module Leader:

A. Objectives:
The course is designed to meet with the following objectives:
1. An understanding of fluid mechanics fundamentals, including concepts of mass and momentum conservation.
2. An ability to apply the Bernoulli equation to solve problems in fluid mechanics.
3. An ability to apply control volume analysis to problems in fluid mechanics.
4. An ability to use potential flow theory to solve problems in fluid mechanics.
5. An ability to perform dimensional analysis for problems in fluid mechanics.
6. Knowledge of laminar and turbulent boundary layer fundamentals.
7. An exposure to recent developments in fluid mechanics, with application to aerospace systems.
8. An ability to apply the concepts developed for fluid flow analysis to issues in aerospace design.

B. Learning Outcome:
Upon completion of the subject, students will have:
1. Knowledge of basic fluid dynamics.
2. Knowledge of control volume analysis.
3. Ability to use differential equations to understand pressure and velocity variations.
4. Knowledge of dimensional analysis.
5. Ability to determine ‘losses’ in flow systems.
6. Understanding of viscosity and its importance in real flows.

C. Subject Matter:
Unit I:
Outline of fluid motion with friction: real and perfect fluids, viscosity and compressibility, similarity principles, comparison between theoretical experimental and numerical study of flow, Concept of boundary layer, boundary layer separation and vortex formation.

Unit II:
Navier Stokes equation: fundamental equation of motion and continuity applied to fluid flows, Stokes hypothesis and N-S equation, Simplification of N-S equation, Normalisation of N-S equation, Order of magnitude and simplification of N-S equation, Prandtl’s Boundary layer Theory & Boundary layer equation.

Unit III:
Laminar boundary layer: boundary layer equation for 2 –D incompressible flow, separation & control of boundary layer, momentum integral equation for boundary layer, Some exact solutions steady state boundary layer equation-flow past a wedge, flow in a convergent channel, and flow past a cylinder.

Unit IV:
**Approximate methods:** solution for flow over flat plate at zero incidences, flow past a circular cylinder, fundamentals of turbulent boundary layer, Reynolds equation, Prandtl's mixing length, Introduction to thermal boundary layer, heat conduction equation from boundary layer equation, general properties of thermal boundary layers, force and natural flows, adiabatic walls.

**D. Teaching/Learning/Practice Pattern:**

Teaching: 70 %
Learning: 30 %
Practice: 0 %

(Teacher is to divide components for T/R/P)

**E. Examination Pattern:**

1. Theoretical Examination

**F. Reading List:**

**Books:**
1. F. M. White, “Viscous fluid flow”, MGH.
3. B. S. Massey, “Mechanics of fluid”.
4. H. Schlichting, “Boundary layer theory”, MGH.

**Magazine:**
1. Pumps & Systems.
2. World Pumps.
3. Hydraulics & Pneumatics.

**Journals:**
3. Considerations Regarding the Mathematical Basis for Prandtl’s Boundary Layer Theory, Paul C. Fife.
Name of the Module: Air and Noise Pollution Control
Module Code: ME 704/11
Semester: 7th
Credit Value: 3[P=0, T=0, L=3]
Module Leader:

A. Objectives:
The course is designed to meet the following objectives:
1. To know harmful effects of pollution.
2. To make students aware of the causes of pollution.
3. To know control of pollution.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Learn how to minimize pollution.
2. Learn how to control harmful effects of pollution.

C. Subject Matter:
Unit I:
Noise Pollution and Control: Basic information of noise, General noise criteria, Noise emission standards, Identification of noise impacts.

Unit II:

Unit III:
Air Pollution and Control: Sources and classification of air pollutants, Meteorology and air pollution, Effect of air pollution, Air pollution due to automobile.

Unit IV:
Control of air pollution by equipment: Air quality emission standards, Air pollution legislation and regulation.

D. Teaching/Learning/Practice Pattern:
   Teaching: 70 %
   Learning: 30 %
   Practice: 0 %

(Teacher is to divide components for T/R/P)

E. Examination Pattern:
1. Theoretical Examination
F. Reading List:

**Books:**
1. Machinzia I. L and D. A. Cornwell, “Introduction to environmental engineering”, MGH.
3. G. Kiely, “Environmental engineering”, MGH.

**Magazine:**
1. Model Engine Builder.
2. Car and Driver.
3. Engine Technology International
4. ES Engineered Systems.

**Journals:**
2. Journal of Chemical Engineering of Japan, Society of Chemical Engineers Japan.
Name of the Module: Non-Traditional Manufacturing

Module Code: ME 704/12
Semester: 7th
Credit Value: 5[P=3, L=3, T=0]
Module Leader:

A. Objectives:
The course is design to meet with the following objectives:
1. Identify the characteristics of conventional machining.
2. Identify the characteristics of non traditional machining.
3. Differentiate between conventional and non traditional machining.
4. Classify different non traditional machining processes.
5. Identify the need for non traditional machining processes.
6. Describe the basic mechanism of material removal in non traditional machining (AJM, WJM, EDM, ECM and USM).
7. Identify major components of non traditional machine equipment.
8. State the working principle of non traditional machine equipment.
9. Draw schematically the non traditional machine equipment.
10. Identify the process parameters of non traditional machine.
11. Identify the machining characteristics of non traditional machine.
12. Analyse the effect of process parameters on material removal rate (MRR).
13. Draw variation in MRR with different process parameters.
14. Develop mathematical model relating MRR with abrasive jet machining parameters.
15. List three applications of non traditional machine.
16. List three limitations of non traditional machine.

B. Learning Outcome:
Upon completion of the subject, students will be able to:
1. Have a clear idea of difference between conventional machining and non traditional machining.
2. Know different non traditional machining processes
3. Know the working principle of non traditional machine equipment.
4. Mechanism of material removal in non traditional machining (AJM, WJM, EDM, ECM, USM).

C. Subject Matter:
Unit I:
New technologies: AJM, WJM, EDM, ECM, USM: working principle, components of set up, field of application, Parameters affecting machining characteristics, Material removal mechanism.

Unit II:
Nano-machining: processing systems of nano-metric accuracies and sub-nanometric processing Resolutions, processing unit, breaking stress and processing energy densities, Mechanism of materials processing based on imperfections or defects in materials.

Unit III:
Nano-mechanical processing of atom clusters and sub-crystal grain units, Nano positioning system applications of nano-technology, Energy beam processing of materials.

D. List of Practical:
1. To find MRR (Metal Removal Rate) of EDM.
2. To Find the MRR of AJM.
3. To find MRR of WJM.
4. To find MRR of ECM.
5. To find MRR of USM.

E. Teaching/Learning/Practice Pattern:

   Teaching: 50 %
   Learning: 30 %
   Practice: 20 %

(Teacher is to divide components for T/R/P)

F. Examination Pattern:
   1. Theoretical Examination.
   2. Practical examination.

G. Reading List:

Books:
   1. Pandey & Shah, “Modern Machining processes”, TMGH.

Magazine:
   1. Manufacturing Maker Spaces.
   2. 3D-Printing and the Future Manufacturing.

Journals:
   1. International Journal of Machining and Machinability of Materials, ISP.