SECTION 2: PROGRAMME EDUCATIONAL OBJECTIVES

(a) The vision and mission of the ESUT and/or Faculty of Engineering (School).

Philosophy

The founding fathers of University conceived a unique university that must be closely related to society, its industry and above all serves as a catalyst in the technological advancement of the people. The emphasis in the programme is to develop and offer academic and professional programs leading to the award of degrees, certificates and other distinctions, to persons who attain the standard prescribed by the university and have in all other respects satisfied the conditions and requirements lay down or otherwise approved by the University.

ESUT Vision

To be premier university in Africa in capacity development that promotes services to the society through quality teaching, research and community service.

ESUT Mission

To promote scholarship, especially in the areas of Science, Management and Technology, thereby ensuring the development of quality manpower that will utilize technology for the service of society

(b) The PEOs and where they are published

ESUT- MECHANICAL AND PRODUCTION ENGINEERING (MPE)
PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The programme educational objectives aims at imparting quality education to Mechanical and Production Engineering students that will position them for effective contribution to the society by the use of modern technologies and practices. **Program Educational Objectives (PEOs)** for a Mechanical Engineering Program is listed below and published in the student handbook

1. PEO 1: Graduates will apply their knowledge of mathematics, science, and engineering principles to analyze and solve complex mechanical engineering problems.
2. PEO 2: Graduates will demonstrate proficiency in using modern engineering tools, techniques, and software to design, model, simulate, and analyze mechanical systems.
3. PEO 3: Graduates will exhibit effective communication and teamwork skills, enabling them to collaborate with multidisciplinary teams and effectively convey technical information to diverse audiences.
4. PEO 4: Graduates will engage in lifelong learning and professional development, pursuing advanced degrees, certifications, and continuing education opportunities to enhance their knowledge and skills in mechanical engineering.
5. PEO 5: Graduates will demonstrate a strong commitment to ethical and professional responsibility in their engineering practice, considering societal, environmental, and economic factors while designing and implementing mechanical systems.

(c) PEOs and Alignment of PEOs with Mission and Vision of ESUT

Describe how the PEOs are consistent with the vision and mission of the institution and/or faculty and stakeholders 'requirements.

The Program Educational Objectives (PEOs) of Mechanical and Production Engineering are consistent with the vision and mission statements of ESUT (Enugu State University of Science and Technology) by aligning with the university's overarching goals and objectives. Here's how the PEOs are consistent:

1. ESUT Vision: "To be premier university in Africa in capacity development that promotes services to the society through quality teaching, research, and community service."

PEO Alignment: The first PEO of the Mechanical and Production Engineering program focuses on preparing graduates to engage in engineering practice or other fields for sustainable development. By equipping students with modern technologies and practices, the program aims to position them for effective contributions to society. This directly aligns with ESUT's vision of promoting services to society through quality teaching and capacity development.

2. ESUT Mission: "To promote scholarship, especially in the areas of Science, Management, and Technology, thereby ensuring the development of quality manpower that will utilize technology for the service of society."

PEO Alignment: The remaining PEOs of the program are consistent with ESUT's mission. The PEOs aim to develop graduates who retain intellectual curiosity, pursue lifelong learning, and apply their mechanical engineering education to address technical and societal problems. This aligns with ESUT's mission of promoting scholarship and developing quality manpower that can utilize technology for the service of society.

Additionally, the PEOs emphasize the graduates' readiness to occupy positions of increasing responsibility, aspire to leadership roles, and exhibit ethical and professional standards. These objectives align with ESUT's mission of developing quality manpower capable of contributing to the community, enhancing qualitative service delivery, and acting as agents of positive change.

By imparting quality education, fostering intellectual curiosity, and emphasizing the importance of professional competence, creativity, and responsibility, the Mechanical and Production Engineering program aligns with ESUT's vision and mission to serve society through education, research, and community service.

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SECTION 3: PROGRAMM OUTCOMES (POs)

a) **List the POs and state where they are published.**

Program Outcomes (POs) for a Mechanical Engineering Program are published in the student handbook where they can easily familiarise themselves with it. At the end of the program, the graduates will be equipped with the ability to:

1. Apply knowledge of mathematics, science, and engineering fundamentals to solve mechanical engineering problems.
2. Design and conduct experiments, as well as analyze and interpret data to evaluate mechanical systems and components.
3. Design and develop mechanical systems, components, or processes that meet desired specifications and performance requirements, considering factors such as safety, reliability, and cost-effectiveness.
4. Use modern engineering tools, software, and equipment to model, simulate, and analyze mechanical systems, and to design and produce engineering documentation.
5. Function effectively as a member or leader of a multidisciplinary team, understanding the importance of teamwork, collaboration, and effective communication.
6. Demonstrate an understanding of professional and ethical responsibilities in mechanical engineering practice, and the impact of engineering solutions in societal, environmental, and economic contexts.
7. Recognize the need for, and engage in, lifelong learning, keeping up with advancements in the field of mechanical engineering and pursuing professional development opportunities.
8. Communicate effectively, both orally and in writing, using appropriate technical language and visual aids to convey technical information to different audiences.
9. Understand the impact of mechanical engineering solutions on global, economic, environmental, and societal issues, and the need for sustainable and ethical practices.
10. Demonstrate knowledge and understanding of contemporary issues in mechanical engineering, including emerging technologies, industry trends, and professional standards

SECTION 4: COURSE LEARNING OUTCOMES (CLOS)

The course learning outcomes for the different courses of the programmed are stated according to the levels below.

a) The CLOs and where they are published. These are published in the student's handbook and online

100 LEVEL COURSES

GST 111: Communication in English (2 Units)

Course Learning Outcomes (CLO):

At the end of the course, the students should be able to:

1. Identify possible sound patterns in English Language;
2. List notable language skills;
3. Classify word formation processes;
4. Construct simple and fairly complex sentences in English;
5. Apply logical and critical reasoning skills for meaningful presentations;
6. Demonstrate an appreciable level of the art of public speaking and listening; and
7. Write simple technical reports.

GST 112: Nigerian Peoples and Cultures (2 Units)

Course Learning Outcomes (CLO):

Upon completion of this course, students will be able to:

1. Analyse the historical foundation of Nigerian cultures and arts in pre-colonial times;
2. Identify and list the major linguistic groups in Nigeria;
3. Explain the gradual evolution of Nigeria as a political entity;
4. Analyse the concepts of trade and economic self-reliance of Nigerian peoples
5. Enumerate the challenges of the Nigerian state regarding nation building;
6. Analyse the role of the judiciary in upholding fundamental human rights

7. Identify the acceptable norms and values of the major ethnic groups in Nigeria; and
8. List possible solutions to identifiable Nigerian environmental, moral and value problems**.**

GST 121: Use of Library, Study Skills and ICT (2 Units)

Course Learning Outcomes (CLO):

Upon completion of this course, students will be able to:

1. Acquaint themselves with the parts of a book and the different types of libraries resources including the use of media resources
2. Understand the purpose of the University Library, the kind of materials it acquires and their physical arrangement and organization.
3. Have a general idea of classification systems used in libraries as God was the first classifier.
4. Know or have knowledge of how to select books on their subject areas as well as spiritual growth
5. Know how to use the card catalogue and ability to search for information beyond the catalogue e.g. internet search.
6. Familiarize them with the major reference books both general and specialized, what they are and how to use them

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ICH 111: General Chemistry I (2 Units)

Course Learning Outcomes (CLO):

Upon completion of this course, students will be able to:

1. Define atom, molecules and chemical reactions;
2. Discuss the modern electronic theory of atoms;
3. Write electronic configurations of elements on the periodic table;
4. Rationalise the trends of atomic radii, ionisation energies, electronegativity of the elements, based on their position in the periodic table;
5. Identify and balance oxidation–reduction equation and solve redox titration problems;
6. Draw shapes of simple molecules and hybridised orbitals;
7. Identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship
8. Apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. Analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. Determine rates of reactions and its dependence on concentration, time and temperature.

ICH 197: General Practical Chemistry I (1 Unit)

Course Learning Outcomes (CLO):

Upon completion of this course, students will be able to:

1. State the general laboratory rules and safety procedures;
2. Collect scientific data and correct carry out chemical experiments;
3. Identify the basic glassware and equipment in the laboratory;
4. State the differences between primary and secondary standards;
5. Perform redox titration;
6. Record observations and measurements in the laboratory notebooks; and
7. Analyse the data to arrive at scientific conclusions.

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MTH 111: Elementary Mathematics I (Algebra and Trigonometry) (3 nits)
Course Learning Outcomes (CLO):
Upon completion of this course, students will be able to:

1. Define and explain set, subset, union, intersection, complements, and demonstrate the use of Venn diagrams;
2. Solve quadratic equations;
3. Solve trigonometric functions;
4. Identify various types of numbers; and
5. Solve some problems using binomial theorem.

PHY 111: General Physics I (2 Units)
Course Learning Outcomes (CLO):
Upon completion of this course, students will be able to:

1. Identify and deduce the physical quantities and their units;
2. Differentiate between vectors and scalars;
3. Describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. Apply Newton's laws to describe and solve simple problems of motion;
5. Evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. Explain and apply the principles of conservation of energy, linear and angular momentum;
7. Describe the laws governing motion under gravity; and
8. Explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

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CEE 121: Computer Programming (3 Units)

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

1. State Filing system. Word processing applications and use.
2. Explain Internet: available services, principle of operation, applications and demonstrations.Spreadsheet: applications and use.;
3. Identify PC parts and peripheral devices.;
4. state the Safety precautions and preventive maintenance of PC;
5. Describe Database management packages: applications and demonstrate them
6. Report presentation using software packages and applications,
7. demonstrations, and use a mini-project to test proficiency in use of these software packages
8. . Apply the use of QBASIC

PHY 197: General Practical Physics I (1unit)
Course Learning Outcomes (CLO):
Upon completion of this course, students will be able to:

1. Conduct measurements of some physical quantities
2. Make observations of events, collect and tabulate data
3. Identify and evaluate some common experimental errors
4. Plot and analyse graphs
5. Draw conclusions from numerical and graphical analysis of data
6. Prepare and present practical reports.

GST 112: Communication in English II (2 Units)
Course Learning Outcomes (CLO):
Upon completion of this course, students will be able to:

1. Advance paragraphs in a logical and coherent manner;
2. Change outlines and create supporting
3. Identify and write topic sentences and attain coherence in written English; sentences

4. Mark various forms of essays (narrative, descriptive, expository and argumentative/persuasive);
5. Distinguish and produce as accurately as possible, the English vowels and consonants;
6. Distribute an effective public speech

GST 118: Peace and Conflict Resolution (2 Units)

Course Learning Outcomes (CLO):

Upon completion of this course, students will be able to:

1. Define and explain the meaning and nature of conflict
2. Discuss the causes and types of conflicts
3. Discuss issues on conflict analysis, management, resolution and transformation
4. Explain the processes of conflict resolution – mediation negotiation, arbitration, litigation, conciliation and so on
5. Give detailed explanation of peace education
6. Examine the role of communication and language in conflicts
7. Explain the importance of the rules of conflict intervention
8. Determine the latent stage of conflict and possible responses
9. Discuss and be familiar with global issues and peace-building.

GST 114: Social Sciences (2 Units)

Course Learning Outcomes (CLO):

Upon completion of this course, students will be able to:

1. Understand the concepts of geography as a scientific discipline
2. Examine the sense of location specification, including an appreciation of forms and structure of Nigerian settlement pattern, economic activities and challenges
3. Provide understanding on the relationships in economic and political geography of both in history and in the contemporary with the aim of creating environmental consciousness

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MEC-122 Basic Engineering Drawing (2 Units)

Course Learning Outcomes (CLOs):
Upon completion of this course, students will be able to:

1. Elucidate drawing as a means of communication.
2. Construct borderlines and dimensioning.
3. Illustrate drawing, measuring, lettering and dimensioning of objects in various views/positions;
4. Identify the various types of lines, their applications and geometry;
5. Demonstrate the geometrical construction of parallel and perpendicular lines, bisection and division of lines,
6. Draw construction and bisection of angles.
7. Construct triangles, inscribed, ascribed and circumscribed circles of triangle, quadrilaterals, polygons, circle and geometrical construction on circle
8. Demonstrate freehand sketching, symbols, conventions an scales

ICH 112: General Chemistry II (3 Units)
Course Learning Outcomes (CLO):
Upon completion of this course, students will be able to:

1. State the importance and development of organic chemistry;
2. Define fullerenes and its applications;
3. Discuss electronic theory;
4. Determine the qualitative and quantitative of structures in organic chemistry;
5. State rules guiding nomenclature and functional group classes of organic chemistry;
6. Determine the rate of reaction to predict mechanisms of reaction;
7. Identify classes of organic functional group with brief description of their chemistry;
8. Discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. Describe basic properties of transition metals.

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ICH 198: General Practical Chemistry II (1 Unit)

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

1. State the general laboratory rules and safety procedures;
2. Collect scientific data and correctly carry out chemical experiments;
3. Identify the basic glassware and equipment in the laboratory;
4. Identify and carry out preliminary tests which include ignition, boiling point, melting point, test on known and unknown organic compounds;
5. Carry out solubility tests on known and unknown organic compounds;
6. Carry out elemental tests on known and unknown compounds; and
7. Carry out functional group/confirmatory test on known and unknown compounds which could be acidic/basic/ neutral organic compounds.

MAT 112: Elementary Mathematics II (Calculus) (3 Units)
Course Learning Outcomes (CLO):
Upon completion of this course, students will be able to:

1. Identify the types of rules in differentiation and integration;
2 .Recognise and understand the meaning of function of a real variable, graphs, limits and continuity;
3. Solve some applications of definite integrals in areas and volumes;
4. Solve function of a real variable, plot relevant graphs, and identify limits and idea of continuity;
5. Identify the derivative as limit of rate of change;
6. Identify techniques of differentiation and perform extreme curve sketching;
7. Identify integration as an inverse of differentiation;
8. Identify methods of integration and definite integrals; and
9. Perform integration application to areas, volumes.

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PHY 112 General Physics II (3 Units)

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

1. Explain the general properties of waves.
2. Describe the general properties of sound.
3. Describe what static electricity is and how it originates.
4. Demonstrate an understanding of electrical potential.
5. Analyse electrical circuits. .
6. Define the properties of magnetic fields.
7. Clarify how light interacts with lenses and mirrors. .
8. Label optical phenomena associated with the wave properties of light.
9. Designate quantum theory and how it relates to the model of the atom

PHY 198 General Practical Physics II (1 Unit)

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

1. Be able to prepare a written laboratory report that effectively interprets and communicates their results.
2. Be able to effectively use computers as a tool for communication, data collection, data analysis.
3. Perform at least 10 laboratory activities where students collect, organize and analyse data demonstrating concepts from the 8 major objectives listed above

MME 122 Engineering Materials – 2 Units
Course Learning Outcomes (CLOs)
At the end of the course the students should be able to:

1. list the main classes of engineering materials.
2. enumerate the important properties of each of the main classes of engineering materials. calculate the total energy of an electron in n^{th} orbit
3. describe the four quantum numbers

4. explain electronic configuration and the aufbau principles.
5. describe the different types of bonding, both primary and secondary bonding, with sketches. name the three most common metal crystal structures and give examples of metals which have each of these crystal structures
6. sketch the unit cells of bcc, fcc and hcp crystal structures and calculate the packing efficiency of each of them.
7. distinguish between a metal, an alloy and a composite material
8. explain different fabrication methods in engineering and give examples of products made from each of them.

200 LEVEL COURSES

Course Learning Outcomes (CLO):
Upon successful completion of the module, students should be able to:

1. Students will have acquired practical knowledge and skills in general engineering, including the operation of hand and powered tools for wood and metal cutting and fabrication.
2. Students will demonstrate a strong understanding of safety protocols and guidelines for using tools and machines, ensuring a safe working environment for themselves and others.
3. Upon completion of the course, students will have gained supervised hands-on experience, successfully applying their knowledge and skills in using tools and machines to complete selected engineering tasks.
4. Students will develop familiarity with various techniques and practices involved in general engineering, demonstrating the ability to select appropriate tools, cut materials, and fabricate components.
5. By the end of the course, students' practical skills in general engineering will be enhanced, as they will have gained hands-on experience and developed problem-solving abilities in real-world engineering scenarios.

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EEE 221 Applied Electricity I (3 Units)

Learning Outcomes
At the end of this course, students will be able to:

1. Discuss the fundamental concepts of electricity and electrical d.c. circuits;
2. State, explain and apply the basic d.c. circuit theorems;
3. Explain the basic a.c. circuit theory and
4. Apply to solution of simple circuits.

MEC 223: Engineering Drawing I (2 Units)
Course Learning Outcomes:

At the end of the course, the students should be able to:

1. Apply multi-view representation techniques accurately to represent objects in different views, demonstrating proficiency in both first and third angle projection methods.
2. Create isometric drawings and simple pictorial assembly drawings, accurately representing the spatial relationship between components and assemblies.
3. Generate oblique drawings using different techniques such as cavalier, cabinet, and angles other than 45 degrees, effectively communicating the shape and features of objects.
4. Apply proper dimensioning techniques, including the selection and placement of dimension lines, the use of tolerances, and the application of GD&T symbols, ensuring clear and accurate communication of size and shape requirements.
5. Interpret and create sections and auxiliary views, correctly representing the internal features and hidden details of objects, and apply the appropriate conventions for representing threads, bolted joints, keys, cottered joints, and other mechanical components based on relevant standards such as BS 308

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CHE 225: Fundamental of Fluid Machines (3 Units)

Course Learning Outcomes:

At the end of this course, the students should be able to:

1. Explain the general concept of fluid and further identifying the properties of fluids,
2. Demonstrate friction effects and losses in laminar and turbulent flows ducts and pipes
3. Analyze the concept of Dimensional analysis and dynamic similitude
4. Explain and illustrate fluids statics conservation laws
5. Analyze the phenomena regarding principles of construction and operation of selected hydraulic machinery.
6. Identify and use hydro power systems.

CVE 227: Applied Mechanics (3 Units)
Course Learning Outcomes (CLO):
At the end of this Course, students should be able to:

1. Analyse the concepts of friction, wear and lubrication applications in kinematics;
2. Explain the principles of selection of power screws, belt, ropes and chains drives,
3. Explain the principles of selection clutches, brakes
4. Explain the principles of selection dynamometer and its application in torque
5. Differentiate between Hydrodynamics and hydrostatic lubrication;
6. Explain tribology and its associated problems

FEG 227: Engineering Mathematics I (3 Units)

Course Learning Outcomes (CLO):
At the end of the course, the students should be able to:

1. Carry out addition and subtraction of complex numbers, multiplication of complex numbers, conjugate complex number and division of complex numbers.

2. Carry out of addition of two vectors, multiplication of vector by scalars, orthogonal triad of unit vectors, vector products, laws of cross products.

3. Describe trigonometric rations and trigonometric identity.
4. Explain exponential functions and logarithmic function
5. Guide to solving partial fractions, solve denominator with repeated and quadratic factors.
6. Carry out arithmetic series, geometric series, geometric mean.
7. See integration as reverse process of differentiation, fine a function whose derivative we already know.
8. Carry out addition and subtraction of polynomials, types of polynomials, multiplication and division of polynomials, factor theorem.

FEG 221: Engineering in Society (2 Units)

At the end of this course, the students should be able to:
1. differentiate between science, engineering and technology, and relate them to innovation;
2. distinguish between the different cadres of engineering – engineers, technologists, technicians and craftsmen and their respective roles and competencies;
3. identify and distinguish between the relevant professional bodies in engineering;
4. categorise the goals of global development or sustainable development goals (SDGs);
5. identify and evaluate safety and risk in engineering practice.

CEE 221: Introduction to Modeling and Simulation (2 Units)

Course Learning Objective (CLO):
At the end of this course, the students should be able to:

1 Have good grasp of design thinking and be obsessed with the determination to apply such to solving simple every day and also complex problems using matlab
2. Recognize the fundamental concepts of functions and basic plotting, vector and matrix generation, array operations, linear and nonlinear equations. Programming (M-file scripts and functions)

3. show good skills in programming languages in the world of engineering objects in actionable solid models, and put such models in a form where they can be inputs for simulation and analyses;
4. Have knowledge og facility development in simulation model building, examples/area of applications prepare the objects for modern production and manufacturing techniques of additive and subtractive manufacturing;
5. Describe some open circuit simulator software like Proteus, Multisim, and PECS

FEG 293: Student Workshop Experience (1 Unit)

Course Learning Outcomes (CLO):
By the end of this course, students should be able to

1. Demonstrate practical knowledge and skills in general engineering, including the operation of hand and powered tools for wood and metal cutting and fabrication.
2. Demonstrate a strong understanding of safety protocols and guidelines for using tools and machines, ensuring a safe working environment for themselves and others.
3. Apply their knowledge and skills in using tools and machines to complete selected engineering tasks.
4. Develop familiarity with various techniques and practices involved in general engineering, demonstrating the ability to select appropriate tools, cut materials, and fabricate components.
5. Developed problem-solving abilities in real-world engineering scenarios.

ENS 222: Introduction to Entrepreneurship (2 Units)

Course Learning Outcomes (CLO):
At the end of this course, students should be able to:

1. Explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation and risk-taking;
2. State the characteristics of an entrepreneur;

3. Analyse the importance of micro and small businesses in wealth creation, employment generation and financial independence;
4. Engage in entrepreneurial thinking;
5. Identify key elements in innovation;
6. Describe the stages in enterprise formation, partnership and networking, including business planning;
7. Describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world;
8. State the basic principles of e-commerce

EEE 222: Applied Electricity II (3 Units)

Course Learning Outcomes (CLO):

At the end of this course, students should be able to:

1. Demonstrate the concept of electrical basic machines
2. Demonstrate DC, synchronous alternators, transformers, equivalent circuits.
3. Exhibit the understanding of converting electronic schematic circuit into printed circuit board (PCB) layout and vice versa using computer aided design (CAD) software.
4. Demonstrate the operation of three phase balanced circuits
5. Read and interpret and test various functional, PN junction Diode, transistors, FRTs, Zener, Rectifiers.
6. Demonstrate the skills to basic control systems, open/close loop systems...
7. Exhibit the understanding of the principles of electrical power generation, transmission, distribution as well as the utilization.
8. Exhibit the understanding of the communications fundamentals, introduction of TV, Radio Telephone systems.

MEC 224: Engineering Drawing II (2 Units)

Course Learning Outcomes (CLO):

At the end of the course, the students should be able to:

1. Apply projection techniques to accurately project points, lines, planes, and solids onto different views, demonstrating proficiency in graphical representation.

2. Analyze and determine intersections of solids, effectively representing complex geometric relationships and providing comprehensive engineering drawings.
3. Interpret and represent cam profiles, showcasing an understanding of cam mechanisms and their applications in mechanical systems.
4. Develop surfaces accurately, utilizing appropriate methods such as ruling and triangulation to represent curved and irregular shapes in engineering drawings.
5. Create detailed drawings of mechanical components, including belts, chains, gears, bearings, lubrication arrangements, couplings, brakes, flexible shafts, universal joints, etc., incorporating appropriate dimensions, tolerances, and annotations to convey design specifications.

FEG 294: Student Workshop Experience (1 Unit)
Course Learning Outcomes (CLO):
At the end of the course, the students should be able to:

1. Demonstrate competency in operating hand and powered tools for wood and metal cutting and fabrication, ensuring accurate and efficient execution of engineering tasks.
2. Apply theoretical knowledge to practical scenarios, effectively utilizing tools and machines to accomplish selected engineering tasks with precision and attention to detail.
3. Exhibit proficiency in executing practical tasks related to general engineering, showcasing an understanding of fundamental principles and practices.
4. Adhere to safety protocols and practices when operating tools and machines, prioritizing personal and workplace safety in all engineering activities.
5. Collaborate effectively in a team environment, demonstrating problem-solving and communication skills through supervised hands-on experiences, fostering an environment of mutual support and shared learning.

CHE 226: Fundamental of Thermodynamics (3 Units)

Learning Outcomes
At the end of this course, the students should be able to:
1. Understand and Analyze the basic concepts of the quantitative relations of zeroth, first, second and third laws of thermodynamics.

2. Identify and evaluate the behavior of pure substances and perfect gases
3. Explain the phenomena of ideal gas cycles
4. Illustrate and use the above theories in solving engineering problems

CVE 228: Strength of Materials (2 Units)

Learning Outcomes

At the end of this course, the students should be able to:

1. recognise a structural system that is stable and in equilibrium;
2. determine the stress-strain relation for single and composite members based on Hooke's law;
3. estimate the stresses and strains in single and composite members due to temperature changes;
4. evaluate the distribution of shear forces and bending moments in beams with distributed and concentrated loads;
5. determine bending stresses and their use in identifying slopes and deflections in beams;
6. use Mohr's circle to evaluate the normal and shear stresses in a multi-dimensional stress system and transformation of these stresses into strains;
7. evaluate the stresses and strains due to torsion on circular members; and
8. determine the buckling loads of columns under various fixity conditions at the ends.

FEG 228: Engineering Mathematics II (3 Units)

Course Learning Outcomes (CLO):

At the end of the course, the students should be able to:

1. Describe physical systems using ordinary differential equations (ODEs);
2. Explain the practical importance of solving ODEs, solution methods, and analytically solve a wide range of ODEs, including linear constant coefficient types;
3. Numerically solve differential equations using MATLAB and other emerging applications;
4. Perform calculus operations on vector-valued functions, including derivatives, integrals, curvature, displacement, velocity, acceleration, and torsion, as well as on functions of several variables, including directional derivatives and multiple integrals;

5. Solve problems using the fundamental theorem of line integrals, Green's theorem, the divergence theorem, and Stokes' theorem, and perform operations with complex numbers;
6. apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions of complex variables, as well as the theory of conformal mapping to solve problems from various fields of engineering; and
7. Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula.

FEG 290: Students Industrial Work Experience (SIWES I) (2 Units)

Course Learning Outcomes (CLO):
SIWES should provide opportunity for the students to:

1. Acquire industrial workplace perceptions, ethics, health and safety consciousness, inter-personal skills and technical capabilities needed to give them a sound engineering foundation;
2. Learn and practise basic engineering techniques and processes applicable to their specialisations;
3. Build machines, devices, structures or facilities relevant to their specific engineering programmes and applications; and
4. Acquire competence in technical documentation (log-book) and presentation (report) of their practical experiences.

300 LEVEL COURSES

MEC 351: Workshop process and Practice III

Course Learning Outcomes (CLO):

1. By the end of this course, students will have acquired practical knowledge and skills in general engineering, including the operation of hand and powered tools for wood and metal cutting and fabrication.

2. Students will demonstrate a strong understanding of safety protocols and guidelines for using tools and machines, ensuring a safe working environment for themselves and others.

3. Upon completion of the course, students will have gained supervised hands-on experience, successfully applying their knowledge and skills in using tools and machines to complete selected engineering tasks.

4. Students will develop familiarity with various techniques and practices involved in general engineering, demonstrating the ability to select appropriate tools, cut materials, and fabricate components.

   By the end of the course, students' practical skills in general engineering will be enhanced, as they will have

FEG 321: Engineering Mathematics III – 3 Units

Course Learning Outcomes (CLOs)
At the end of the course the students should be able to:

1. Apply Laplace transforms to find solutions for a variety of common functions and use them to solve differential and simultaneous equations in engineering problems.
2. Analyze and apply Fourier series to study periodic phenomena, enabling the understanding and prediction of periodic signals in engineering applications.
3. Utilize the Jacobian tensor and transformation techniques to describe and analyze the behavior of multidimensional systems in engineering problems
4. Apply numerical analysis methods, including operational methods and special functions, to approximate solutions for complex engineering problems, ensuring accuracy and efficiency.
5. Implement Euler and Runge-Kutta techniques to numerically solve differential equations, demonstrating the ability to model and simulate engineering systems accurately

FEG 322: Advanced Engineering Mathematics IV

At the end of the course, students will be able to:

1. use Mathematical tools in solving complex Engineering mathematical problemes.
2. employ Simple approach in Solving Numerical integration, Laplace transformation , various level of differential equations.
3. explain and Calculate Sturm-Liouville Boundary value problems and Fouries Series Partial Differential Equation.

4. discuss and Solve Linear, Homogenous and Partial differential equations of 9th order with Constant Coefficients.
5. explain and use different techniques in solving Integral Transforms .

MEC 344 : Theory of Machines I (2 Units)

Course Learning Outcomes (CLO):

Upon completion of this course, students will be able to:

1. Analyse and interpret vector diagrams associated with simple mechanisms, demonstrating an understanding of their behavior and functionality.
2. Analyse and calculate parameters related to simple harmonic motion, applying this knowledge to mechanical systems.
3. Analyze and design structural components of machines, applying the theory of structures to ensure stability and structural integrity.
4. Analyze the dynamics of linear systems, apply balancing techniques, and understand the principles and applications of gear systems and gear trains in mechanical systems.
5. Determining the velocity and acceleration of machine elements using both analytical and graphical approaches, with a particular focus on the analysis of slider-crank and quick return mechanisms.
6. Apply instantaneous center methods and calculate forces required to accelerate machine elements, demonstrating an understanding of their effects and implications.

MEC 326: Engineering Drawing III

Course Learning Outcomes:

At the end of the course, the students should be able to:

1. Create detailed and accurate 2-D and 3-D drawings using AutoCAD, demonstrating proficiency in utilizing its various tools and features.

2. Produce engineering drawings using SolidWorks that effectively communicate design intent and specifications.
3. Apply descriptive geometry principles to accurately represent complex shapes, intersections, and projections in engineering drawings.
4. Incorporate appropriate limits and fits in engineering drawings to ensure proper assembly and functionality of components.
5. Communicate design requirements and specifications effectively through the application of geometric tolerancing principles in engineering drawings.

MEC 331: Mechanics of Materials I Prerequisite: EEE 151, CVE III, CVE 213 (2 Units)

Course Learning Outcomes (CLO):
At the end of the course, the students should be able to:

1. Apply the principles of triaxial and combined stresses to analyze and predict the behavior of materials and structures under different loading conditions.
2. Determine the failure theories and criteria that govern the behavior and failure of materials under specific loading conditions, and apply them to practical engineering problems.
3. Analyze and design thin-walled and thick-walled pressure vessels, considering the effects of internal and external pressures, as well as the design considerations for riveted and welded joints.
4. Calculate and analyze shear forces and bending moments in beams, including reinforced concrete beams, to determine their structural integrity and suitability for specific applications.
5. Evaluate the behavior and design considerations for beams with non-round cross-sections, curved beams, and hollow beams with thin-walled sections, considering their load-carrying capabilities and structural performance in different engineering scenarios.

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MEC 332: Mechanics of Materials II Prerequisite: MME 335, Year 3 (2 Units)

Course Learning Outcomes:

At the end of the course, the students should be able to:

1. Calculate and analyze deflection in beams using appropriate methods, demonstrating an understanding of solution techniques and their limitations.
2. Evaluate the shear stress distribution in beams and determine the deflection due to shear, including the identification and utilization of the shear center.
3. Analyze and predict the behavior of beams under unsymmetrical bending, considering the resulting stresses, deformations, and structural integrity.
4. Apply strain energy methods to analyze and design structures and thin members, considering the distribution of internal forces, displacements, and potential energy.
5. Design and analyse helical and leaf springs, considering their mechanical behavior, load-carrying capacity, and performance characteristics in different applications.

MEC 397: Laboratory Practical I (2 Units)

Course Learning Outcomes:

1. Perform laboratory experiments related to fluid flow, such as measuring discharge over weirs, impact of a jet, discharge through an orifice, flow through a Venturi, and friction loss in pipes, demonstrating proficiency in using relevant apparatus and techniques.
2. Collect and analyze experimental data related to fluid flow, applying appropriate calculations and analysis methods to obtain accurate results.
3. Conduct laboratory experiments to measure and analyze vibrations, demonstrating proficiency in using vibration measurement instruments and techniques.
4. Conduct laboratory experiments to measure and analyze torsion in mechanical systems, demonstrating proficiency in using torsion measurement instruments and techniques.

5. Communicate experimental findings effectively, both orally and in written form, including presenting experimental procedures, data analysis, and conclusions in a clear and organized manner.

MEC 398: Laboratory Practicals II (2 Units)

Course Learning Outcomes:

At the end of the course, the students should be able to:

1. Perform laboratory experiments related to thermodynamics, demonstrating proficiency in measuring thermodynamic properties and analyzing thermodynamic processes.
2. Conduct laboratory experiments in fluid mechanics, accurately measuring flow rates, pressures, and forces, and applying relevant principles and equations to interpret and analyze the data.
3. Conduct laboratory experiments in heat transfer, accurately measuring heat transfer rates, temperature distributions, and thermal conductivity, and applying relevant principles and equations to interpret and analyze the data.
4. Utilize appropriate experimental techniques and instrumentation in conducting laboratory experiments in thermodynamics, fluid mechanics, and heat transfer, ensuring accurate data collection and analysis.
5. Analyze and interpret experimental data, draw meaningful conclusions, and effectively communicate the results through written reports and oral presentations in the fields of thermodynamics, fluid mechanics, and heat transfer.

MEC 351: Workshop Practice (2 Units)

Course Learning Outcomes:

1. Demonstrate knowledge and application of safety measures in the workshop, including electrical workshop environments, hand and powered tools, and various measuring devices.

2. Operate and utilize a range of workshop tools and machines effectively and safely, including gauges, micrometers, drilling machines, lathes, grinding machines, milling machines, shaping machines, welding equipment, and woodworking tools.
3. Apply woodworking techniques, including wood selection, joint types, wood preparation, and preservation, to perform tasks and create basic woodwork projects.
4. Execute basic brickwork and masonry skills, including setting out equipment using working drawings, bonding, plumbing, leveling, gauging, and erecting corners in brick/block work.
5. Demonstrate basic electrical skills and knowledge, including testing electrical installations and circuits, understanding electrical safety practices, and applying appropriate safety measures when working with electrical equipment.

MEC 342: Engineering Mechanics (2 Units)

Course Learning Outcomes:

At the end of the course, the students will be able to:

1. Apply Newtonian principles to analyze and solve dynamical problems, demonstrating an understanding of the laws of motion and their practical application.
2. Analyze and interpret particle kinematics, including rectilinear and plane curvilinear motion, and apply the principle of conservation of momentum to solve problems related to particle motion.
3. Analyze and interpret kinematics of rigid bodies, including fixed bodies and fixed axes of rotation.
4. Analyze and interpret kinetics of rigid bodies, including the general equation of motion, and apply the principles of work, energy, work-energy relations, virtual work, impulse, and momentum to solve problems related to the motion and forces of rigid bodies.
5. Apply problem-solving skills to complex dynamical systems, utilizing the principles and concepts learned in the course to analyze, interpret, and solve problems related to the motion, forces, and energy of particles and rigid bodies.

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MEC 353: Manufacturing Technology (2 Units)

Course Learning Outcomes:

At the end of the course, the students should be able to:

1. Demonstrate knowledge and implementation of industrial safety practices and accident prevention measures in a manufacturing environment.
2. Apply principles of ergonomics to optimize workspaces, tools, and equipment in manufacturing settings, ensuring worker comfort, safety, and productivity.
3. Utilize basic metrology techniques to measure and control quality in meal component manufacturing processes.
4. Apply various manufacturing processes, including casting, forging, press steel work, spinning, metal joining, and heat treatment, to produce mechanical components effectively and efficiently.
5. Apply specific machine techniques such as slotting, grinding, broaching, and modern machining methods.

MEC 361: Thermodynamics I (2 Units)

Course Learning Outcomes:

1. Demonstrate a comprehensive understanding of thermodynamics, differentiating between the macroscopic and microscopic domains and recognizing the relationship between statistical and classical thermodynamics in equilibrium.
2. Apply the first law of thermodynamics to closed systems, including the concepts of internal energy, work, non-work processes, and the sign conventions in heat and work transfer.
3. Apply the properties of different working fluids, in solving real world problems
4. Apply the principles of ideal gases and various gas processes, including understanding the behavior of perfect gases, ideal gases, and P-V-T constants

5. Apply the second law of thermodynamics to heat engines and refrigerators, heat pumps,

MEC 371: Fluid Mechanics I (2 Units)

Course Learning Outcomes:

1. Demonstrate a comprehensive understanding of incompressible flow principles, including hydrostatics, the mass conservation equation, and the differential equations of motion for inviscid flows.
2. Apply Bernoulli's equation and the principles of linear and angular momentum to solve engineering problems related to fluid flow, including pipe flow, duct flow, and the analysis of drag and lift.
3. Analyze vorticity and potential flows, understanding their characteristics and applications in engineering problems. Interpret the equations governing viscous fluid flow and explore special solutions.
4. Apply dimensional analysis and modeling techniques to flow problems, enabling the prediction and analysis of fluid flow phenomena based on scaling and modeling principles.
5. Analyze flow with heat losses and gain in pipes and ducts, including an understanding of boundary layers, separation, and their implications in fluid flow. Interpret and analyze these phenomena in practical scenarios.

MEC 312 Engineering Drawing III Prerequisite: MEC 211, MEC 212 Year 3 (2 Credits)

Course Learning Outcomes (CLO):

Upon completion of this course, students will be able to:

1. Demonstrate advanced proficiency in working with loci, accurately constructing epicycloids and hypocycloids and understanding their practical applications in engineering.
2. Possess a comprehensive understanding of screw threads and fastenings, including their design principles, proper selection, and their role in securing components in mechanical systems.

3. Demonstrate proficiency in projecting lines, plane areas, and solids on auxiliary planes, accurately representing complex geometries and providing detailed engineering drawings.
4. Create assembly drawings and prepare schedules of parts, effectively communicating the assembly process and identifying individual components.
5. Represent limits, fits, tolerances, and surface finish on drawings, adhering to industry standards and conventions.

400 LEVEL COURSES

MEC 463: Heat and Mass Transfer I (2 Units)
Course Learning Outcomes:

At the end of the course, the students should be able to:

1. Demonstrate a comprehensive understanding of heat transfer principles, including conduction, convection, and radiation. Understand the nature of thermal conductivity in liquids, solids, and gases and how it varies with temperature and pressure.
2. Apply the principles of one-dimensional steady-state conduction to analyze heat transfer in various scenarios, including solving problems related to heat transfer in plane walls and cylindrical tubes.
3. Understand the basics of convective heat transfer, including the different modes of convection and factors influencing convective heat transfer. Gain familiarity with heat exchanger designs and their applications.
4. Analyze conduction with and without heat generation in different mediums, understanding the mechanisms and equations governing heat transfer in these scenarios. Solve problems related to conduction in various materials.
5. Understand the principles of radiative heat transfer, including the nature of radiation and its interaction with different surfaces. Recognize the factors affecting radiative heat transfer and its applications in various contexts.

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MEC 433: Advanced Mechanics of Materials (2 Units)

Course Learning Outcomes:

At the end of this course, the studenst should be able to:

1. Demonstrate a comprehensive understanding of the mechanics of thick cylinders and compound cylinders, including the principles and techniques for analyzing the stresses and deformations in these structures.
2. Analyze the bending behavior of flat plates, determining the stresses and deflections in various plate configurations and understanding the concept of plate bending.
3. Understand the behavior of beams on an elastic foundation, including the theory and techniques for analyzing the stresses, deformations, and stability of such systems.
4. Analyze the membrane stresses in shell structures of revolution, understanding the concepts and techniques for evaluating these stresses and their distribution in various shell configurations.
5. Apply the principles of the two-dimensional theory of elasticity and analyze elasticity to plastic problems and limit theory, understanding the behavior of materials under both elastic and plastic deformations and being able to solve related problems.

MEC 431: Mechanical Engineering Design I (3 Units)
Course Learning Outcomes:

At the end of the course, the students should be able to:

1. Demonstrate a comprehensive understanding of the behavior and analysis of various structural elements, including thick cylinders, compound cylinders, rotation disks, bending of flat plates, beams on an elastic foundation, and membrane stresses in shell structures of revolution.
2. Analyze and design mechanical connections, such as key and splines, shrink fits, power screws, bolts and nuts, studs, and welds. Understand their function, analyze stress concentrations, and optimize tightening methods.

3. Understand the principles and applications of flexibility elements, such as springs and vibration dampers. Analyze their behavior and apply them appropriately in mechanical systems.
4. Analyze constraint elements, including limited bearings (plain, ball, roller, and tilting pad). Understand their principles, analyze their effects, and apply them in mechanical systems.
5. Explore the design and manufacturing aspects of pressure vessels and gaskets, including their design principles, manufacturing methods, and limitations and fits. Understand the economic considerations involved in designing and manufacturing mechanical components and systems.

MEC 461: Thermodynamics II (2 Units)

Course Learning Outcomes

Upon completion of this course, students will be able to:

1. Describe the steps involved in the design of a steam power plant in a concept map
2. Develop a simulation model of steam power plant with/out superheat and reheat including regenerative rankine cycles to analyse their performance (thermal efficiency, net power output, and mass flow rates), and to prepare an engineering report describing the model and its outcome
3. Evaluate and discuss the effects on steam Rankine cycle performance of varying steam generator pressure, condenser pressure, and turbine inlet temperature using software tools and hand calculation.
4. Discuss the principal sources of exergy destruction and loss in a vapour power plants and possible ways to minimise them.
5. Prepare a technical report describing the design of a gas turbine power plant and refrigeration system for a given constraint/application including design calculations and in-class presentation of the results.
6. Model and analyse the performance of gas turbine–related hybrid applications involving combined gas turbine–vapor power plants.

7. Apply thermodynamic laws (mostly conservation of mass, energy and the 2nd law) to model thermodynamics systems (Compressors, piston-cylinder systems, waste heat boiler, gas turbine, tank etc) involving ideal gas mixtures/combustion

MEC 475: Fluid Mechanics and Transport Processes II Prerequisite: MEC 371 (3 Units)

Course Learning Outcomes for "Fluid Mechanics and Applications":
At the end of the course, the students should be able to:

1. Apply fluid mechanics principles to analyze and solve specific problem areas, such as lift and drag in real-world applications.
2. Analyze and predict fluid flow characteristics in open and closed conduits, including the understanding of boundary layers, separation, and their impact on flow behavior.
3. Apply similarity laws and modeling techniques to scale and simulate fluid flow scenarios, allowing for predictions and analysis in different contexts.
4. Analyze and interpret the behavior of steady compressible fluid flows, including subsonic and supersonic flows, shock waves, and the effects of friction on flow properties.
5. Create solutions to problems related to wave phenomena in fluid mechanics using the method of characteristics, and understand their applications in population dynamics and other relevant fields.

MEC 499: Laboratory Pacticals III (2 Units)

Course Learning Outcomes:
At the end of the course the students should be able to:

1. Demonstrate proficiency in conducting laboratory experiments related to thermodynamics and heat engines, including the ability to set up and operate the shell point engine, analyze the performance of two-stroke engines, and investigate the impact of compression ratios on engine efficiency.
2. Apply experimental techniques and analyze data from mechanics experiments, specifically with the tiling pad apparatus and whirling of shafts, to understand the behavior of rotating systems and the effects of different parameters.

3. Perform heat transfer experiments to measure and analyze heat transfer mechanisms such as conduction, convection, and radiation, and interpret experimental results to enhance understanding of heat transfer principles.
4. Develop skills in experimental setup, data collection, and measurement techniques relevant to the specific laboratory experiments in thermodynamics, mechanics, and heat transfer.
5. Apply critical thinking and problem-solving skills to troubleshoot experimental setups, identify sources of error, and make accurate and reliable measurements in the laboratory environment.

FEG 490: Students Industrial Work Experience III (SIWES III) (6 Units)
Course Learning Outcomes:
At the end of the course the students on Industrial Work Experience Scheme (SIWES) **should be able to:**

1. Be exposed and prepared for the Industrial work situation they are likely to meet after graduation, by developing their occupational competencies;
2. Bridge the existing gap between theory and practice of programmes through exposure to real-life situations, including machines and equipment handling, professional work methods and ethics, human relations, key performance assessment methods, and ways of safeguarding the work environment – human and materials;
3. experience/simulate the transition phase of students from school to the world of work and the environment seamlessly,and expose them to contacts for eventual job placements after graduation;
4. be motivated to identify the industrial and practice engineering challenges of their place of engagement and the larger society and creatively device impactful solutions to them; and
5. exploit the opportunity to improve and utilise their acquired critical thinking and innate creativity skills, during the program and SIWES Seminar presentation respectively.

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MEC 441: Computers and Computational Methods/ Advanced CAD & CAM (3 Units)

Course Learning Outcomes:
At the end of the course, the students should be able to:

1. Identify and quantify numerical errors in engineering calculations, including round-off errors and truncation errors, and their propagation through mathematical operations.
2. Apply regression methods, both linear and nonlinear, and multiple linear regression, to mode
3. Analyze engineering data sets, and interpret the statistical significance of the obtained results.
4. Apply statistical methods to represent and analyze engineering data, make informed decisions based on data analysis, and conduct hypothesis testing to validate engineering hypotheses.
5. Solve linear equations using numerical methods such as Gaussian elimination, Gauss-Sidel methods, and Newton-Raphson iteration, and apply these methods to solve engineering problems.
6. Utilize MATLAB/SCILAB software to solve engineering problems, including the solution of ordinary differential equations, data analysis, and modeling, and effectively communicate engineering solutions using appropriate software tools.

MEC 447: Theory of Machine II (2 Units)

Course Learning Outcomes:
At the end of the course, the students should be able to:

1. Analyze and describe the characteristics and behavior of periodic motion, including simple harmonic motion and sinusoidal motion, and apply them to real-world engineering systems.
2. Apply energy methods to solve problems related to free vibration in prismatic bars and cantilevers, and analyze the natural frequencies and mode shapes of vibrating systems.
3. Analyze and evaluate the behavior of damped vibrations and forced periodic motion in engineering systems, including the impact of external forces and damping on system response.

4. Analyze and design systems with two degrees of freedom, including dynamic absorbers, to mitigate vibrations and improve system performance.
5. Apply principles of vibration analysis to measure and analyze torsional systems, single rotor systems, two-systems, and geared systems, including the determination of critical speeds and the identification of whirling phenomena.
6. Utilize the Rayleigh-Ritz equation and other relevant methods for the design and optimization of dynamic systems, such as balancing machinery and reducing vibrations.

500 LEVEL COURSES

MEC 575: Fluid Dynamics (2 Units)

Course Learning Outcomes
At the end of the course, the students should be able to:

1. Apply Mach number and stagnation properties relations in solving one dimensional compressible flow problems with and without heat transfer
2. Describe characteristic physical features of different compressible flow regimes (subsonic, transonic, supersonic, and hypersonic).
3. Identify and contrast theoretical formulations suitable to mathematically describe each flow regime and explain the range of applicability of the underlying assumptions.
4. Solve one dimensional compressible flow problems involving area change
5. **Solve** two dimensional compressible flow problems involving oblique shock waves, Prandtl-Meyer expansion waves.
6. Apply computer programs (Matlab, Excel, EES, Javascript calculators, etc.) to compressible-flow problems.
7. Identify the various types of flow that occur with compressible gas flow through nozzles
8. Design convergent-divergent nozzles for given applications
9. Determine what types of engine intake systems that should be used with various subsonic and supersonic aircraft
10. Determine the effects of viscous stresses and heat transfer on compressible fluid flows
11. Calculate heat transfer rates to and from external surfaces in high-speed compressible flows

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MEC 543: Theory of Elasticity and Fracture (2 Units)

Course Learning Outcomes for "Theory of Elasticity and Fracture":
At the end of the course, the students should be able to:

1. Apply the principles and equations of elasticity theory to analyze and solve two- and three-dimensional engineering problems, including stress concentration in various geometries under point loading.
2. Utilize experimental stress analysis techniques, such as strain gauging, photoelasticity, and photography, to measure and analyze stress and strain distributions in engineering components, and interpret the obtained data.
3. Apply approximate methods, including the finite element method, to analyze and predict the behavior of complex engineering systems and structures under different loading conditions.
4. Analyze and evaluate the conventional design concepts and criteria related to fractures, including the mechanics of fracture, and assess the failure behavior of materials and structures under fracture conditions.
5. Demonstrate proficiency in applying the principles and techniques learned in the course to solve practical engineering problems related to stress analysis and fracture mechanics, and effectively communicate the findings and solutions to others.

MEC 597: Laboratory Practical IV (3 Units)

Course Learning Outcomes:
At the end of the course, the students should be able to:

1. Successfully conduct laboratory experiments related to refrigeration and air-conditioning systems, and analyze and interpret the obtained data to evaluate system performance and characteristics.
2. Apply experimental techniques and analysis methods to measure and analyze vibrations in mechanical systems, and interpret the results to assess system behavior and performance.

3. Design and conduct mechatronic experiments, integrate mechanical, electrical, and control components, and demonstrate proficiency in mechatronic system design and implementation.
4. Conduct experiments to measure and analyze mechanical properties of engineering materials, and interpret the obtained data to evaluate material performance and behavior.
5. Conduct experiments to study the effects of heat treatment processes on metals, analyze the structure and properties of heat-treated materials, and understand the principles and techniques of casting processes. Effectively communicate experimental procedures, results, and findings through comprehensive laboratory reports.

MEC 564: Tribology (2 units)

Course Learning Outcomes for "Friction, Lubrication, and Bearing Design":

At the end of the course, the students should be able to:

1. Apply the theories of friction to analyze and predict the behavior of metallic and non-metallic surfaces under dry and lubricated conditions, and evaluate the factors influencing friction and wear in engineering systems.
2. Evaluate the properties of materials relevant to friction and wear, and apply appropriate testing methods to assess the performance and suitability of materials in frictional applications.
3. Analyze the characteristics and performance of different types of lubricants, both solid and liquid, and select suitable lubricants based on their properties and compatibility with specific applications.
4. Analyze and solve lubrication problems in self-acting and pressurized bearings using the Reynolds equation and its solutions, considering the effects of dynamic loading, temperature, and pressure on lubricant viscosity and performance.
5. Analyze and design efficient and reliable lubrication systems for gears and rolling contact bearings, taking into account elastohydrodynamic lubrication principles, load capacity requirements, and other design considerations. Additionally, demonstrate proficiency in

designing journals and thrust bearings, considering factors such as load capacity, stability, and lubrication requirements.

MEC 576: Turbomachinery (2 Units)

Course Learning Outcomes:
At the end of the course, the students should be able to:

1. Apply the moment of momentum principles to analyze and design turbines, compressors, pumps, and fans, and evaluate their performance and efficiency in different operating conditions.
2. Analyze and interpret turbine performance characteristics, including specific speed, and understand the factors influencing turbine performance, such as flow rate, head, and efficiency.
3. Evaluate the requirements of pump systems and their loads, and select and design pumps that match the specific operating conditions, considering factors such as flow rate, head, and efficiency.
4. Apply cascade theory to analyze the aerodynamic behavior of cascades, considering the effects of Mach numbers, and predict the performance characteristics of cascades.
5. Evaluate and optimize the performance of fluid machinery systems, considering factors such as efficiency, flow rate, head, and matching with loads. Additionally, effectively communicate the analysis, design, and evaluation of fluid machinery systems through technical reports and presentations.

MEC 533: Mechanical Engineering Design II (2 Units)

Course Learning Outcomes for "Mechanical Engineering Design II":
At the end of the course, the students should be able to:

1. Evaluate and apply dimensional determinations and failure theories, such as the maximum shear stress theory, maximum distortion energy theory (von-Mises-Hencky criterion), and maximum normal stress theory, to analyze and ensure the safety and reliability of mechanical designs.

2. Analyze and interpret S-N diagrams and understand the effects of fluctuating stresses, shock loads, and transmitted loads on fatigue failures, and apply appropriate design factors for safety and strength reduction.
3. Apply methods to reduce stress concentration in designs, such as optimizing geometric configurations and selecting suitable materials, and effectively apply these techniques in the design of shafts and other components.
4. Analyze and select appropriate materials for engineering design based on their mechanical properties, corrosion resistance, and suitability for specific applications, and justify material selection decisions.
5. Incorporate considerations for design development, including ergonomics and aesthetics, into the design process, and effectively communicate design solutions that meet both functional and aesthetic requirements.

MEC 534: Mechanical Engineering Design III Power, Energy and Motion Transfer (2 Units)

Course Learning Outcomes:
At the end of the course, the students should be able to:

1. Analyze and select appropriate flexible drives, such as flexible couplings, belts, ropes, and V-ropes, based on the requirements of mechanical systems, and effectively design and integrate them for efficient motion and power transmission.
2. Analyze and select suitable solid drives, including toothed belts, chains, spur gears, helical gears, bevel gears, and worm gears, for specific applications, considering factors such as load capacity, speed, and efficiency.
3. Evaluate and select appropriate clutches and brakes for mechanical systems, considering factors such as torque capacity, engagement/disengagement characteristics, and safety requirements.
4. Analyze and design flywheels for energy storage and release in mechanical systems, considering factors such as rotational inertia, energy capacity, and stability.

5. Analyze and design motion transfer mechanisms, such as cams and linkages, to achieve specific types of desired motion in mechanical systems, and effectively communicate the design solutions and their functional characteristics.

MEC 565: Applied Thermodynamics (2 Units)

Course Learning Outcomes:

At the end of the course, the students should be able to:

1. Apply thermodynamics relations and processes to analyze and evaluate the performance of turbo machinery systems, and effectively communicate the results through technical reports and presentations.
2. Classify and describe the operating principles of various types of turbo machines, including axial flow and centrifugal machines, and analyze their idealized performance using momentum principles and velocity triangles.
3. Develop models to calculate and interpret important parameters in turbo machinery, such as efficiency, flow coefficient, pressure coefficient, specific speed, specific diameter, and power coefficient, and utilize these parameters in the design and selection of turbo machines.
4. Utilize non-dimensional parameters to present and analyze data in turbo machinery, and effectively apply dimensional analysis techniques to improve the design and performance of turbo machines.
5. Analyze and evaluate the significance of airfoils, linear cascades, lift, and drag in turbo machinery and airplane performance, and understand the role of theoretical analysis, wind tunnels, and water tanks in the development and improvement of turbo machinery systems.

MEC 599A: Seminar (3 Units)

Course Learning Outcomes for seminar

At the end of this seminar course, the students should be able to:

1. Identify an engineering research problem;
2. Demonstrate proficiency in PowerPoint presentation in a seminar;
3. Demonstrate a methodology for actualising aims and objectives of a research project;
4. Partake in a group research project seminar efficiently

5. Submit report comprising a topic, executive summary, problem statement, aims and objectives and methodology.

MEC 599B: Project (6 Units)

Learning Outcomes for Student Undergraduate Degree Project:
At the end of the course, the students should be able to:

1. Develop a research proposal or project plan that clearly defines the research question or project objective, identifies the scope and significance of the work, and outlines the proposed methodology or approach.
2. Conduct a comprehensive literature review, synthesizing relevant scholarly sources and identifying key theories, concepts, or prior research findings that inform the research or project.
3. Apply appropriate research methods or project management techniques to collect and analyze data or evidence, demonstrating proficiency in data collection, data analysis, and the use of relevant software or tools.
4. Interpret and critically evaluate the findings or outcomes of the research or project, drawing valid conclusions and identifying implications or potential areas for further investigation.
5. Present the research or project findings effectively through a final report, presentation, or other appropriate medium, demonstrating clear and concise communication, adherence to academic standards, and the ability to engage and respond to questions or feedback from an audience.
6. Demonstrate a methodology for actualising aims and objectives of a research project;
7. Partake in a group research project defense efficiently
8. Submit report comprising a topic, abstract, problem statement, aims and objectives and methodology, experimentation and/or analysis, results and analysis, conclusion and recommendation

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PUBLISHING OF OUTCOME BASED EDUCATION (OBE)

FOR DEPARTMENT OF MECHANICAL & PRODUCTION ENGINEERING

MEC 582: Engineering Management (2 Units)

Course Learning Outcomes for "Principles of Organization and Management":
At the end of the course, the students should be able to:

1. Apply the principles of organization and management by objectives to real-world organizational situations, demonstrating the ability to develop effective organizational structures and management strategies.
2. Analyze financial statements, apply accounting methods, and use cost planning and control techniques to make informed financial decisions and evaluate the financial health of an organization.
3. Demonstrate proficiency in budgeting and budgetary control, and effectively use depreciation accounting and asset valuation methods to assess the value and performance of assets.
4. Apply principles of personnel management to effectively select, recruit, train, and evaluate employees, and demonstrate an understanding of the role of industrial psychology in managing human resources.
5. Apply resource management techniques, including contracts, interest formulae, and rate of return analysis, and use planning, decision-making, forecasting, scheduling, and production control techniques to optimize resource utilization and improve organizational efficiency.

MEC 583: Engineering Law (2 Units)

Course Learning Outcomes for "Engineering Law":
At the end of the course, the students should be able to:

1. Analyze and interpret legal cases and statutes related to engineering law, demonstrating an understanding of the common law system and its application in legal practice.
2. Apply principles of equity in legal scenarios, recognizing and addressing the specific spheres where equitable remedies may be appropriate.

3. Analyze and evaluate contracts in an engineering context, identifying and interpreting the elements of offer, acceptance, communication, and termination, and assessing the legal implications of contractual obligations.
4. Evaluate and apply general principles of criminal law to engineering situations, recognizing legal liabilities and obligations, and demonstrating an understanding of the potential consequences of unlawful actions.
5. Assess and analyze legal issues related to tort law and patents in engineering practice, including requirements, application, and infringement, and demonstrate an understanding of legal strategies for protecting intellectual property and managing potential liabilities.

MEC 566: Heat and Mass Transfer II (2 Units) (2 Units)

Course Learning Outcomes for "Heat and Mass Transfer II":
At the end of the course, the students should be able to:

1. Apply analytical, graphical, and numerical methods to solve unsteady conduction heat transfer problems, demonstrating proficiency in analyzing and predicting transient heat transfer phenomena.
2. Utilize electrical analogue circuits to model and analyze heat transfer systems, demonstrating the ability to apply analogies and principles to solve complex heat transfer problems.
3. Analyze laminar boundary-layer flows and heat transfer using the momentum and energy equations, and evaluate the impact of different parameters on the boundary-layer characteristics.
4. Apply approximate solutions of the boundary-layer energy equation to estimate heat transfer characteristics in various engineering scenarios, considering factors such as flow separation and laminar-turbulent transition.
5. Analyze and solve advanced heat transfer problems, including energy transfer with phase change, radiation heat transfer, and heat conduction with moving boundaries, demonstrating an understanding of the underlying physical mechanisms and mathematical models associated with these phenomena.

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MEC 568: Refrigeration and Air-Conditioning (2 Units)

Course Learning Outcomes for "Refrigeration and Air-Conditioning":
At the end of the course, the students should be able to:

1. Apply thermodynamic principles and laws to analyze and evaluate the performance of refrigeration and air-conditioning systems, demonstrating proficiency in solving problems related to ideal gases, vapors, and thermodynamic processes using both hand and software calculations
2. Describe the historical development of refrigeration systems and explain the operating principles of various refrigeration systems, including vapor compression, air-cycle, steam-jet, and absorption systems.
3. Calculate and analyze the thermodynamic parameters of vapor compression refrigeration cycles, including the reversed Carnot cycle and the coefficient of performance, and evaluate and present a report of their impact in system performance. Discuss findings in class as a group
4. Utilize hand calculation and software tools to analyze and design typical real world problem in vapor compression refrigeration systems, including considerations for compressor selection, cylinder design, and refrigerant selection, while considering.
5. Evaluate and design key components of refrigeration and air-conditioning systems, including condensers, evaporators, system controls, and air conditioning systems, and apply psychometric charts to estimate space cooling load and design conditions for air cooling, demonstrating an understanding of the underlying principles and considerations.

MEC 543: Control System (2 Units)

Course Learning Outcomes for "Control Systems":
At the end of the course, the students should be able to:

1. Analyze and interpret the dynamics of control systems, including the identification of system components, the determination of transfer functions, and the representation of control systems using block diagrams.

2. Evaluate the stability of control systems using stability criteria, such as the root locus or frequency response analysis, and determine the impact of stability on system behavior and performance.
3. Interpret and analyze system responses, including transient and steady-state responses, and determine key characteristics such as response time, overshoot, damping, and steady-state error.
4. Design and implement control loops using three-term controllers, considering factors such as proportional, integral, and derivative gains, and apply tuning methods to optimize system performance and stability.

   Understand the principles of measurement and instrumentation in control systems, including the transfer function of measurement devices, the impact of response time on system behavior, and the limitations and constraints of measurement