**Bayero University, Kano (BUK)**

**Faculty of Engineering**

**Department of Mechanical Engineering**

**Proposed 30% Additional Courses to CCMAS**

**100 Level**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S/N** | **100 Level Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| 1 | BUK-MEE 102 | General Physics III | 2 | C | 30 | - |
| 2 | BUK-MEE 103 | General Physics IV | 2 | C | 30 | - |
|  | **Total** | | **4** |  |  |  |

**200 Level**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S/N** | **200 Level Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| 1 | BUK-MEE 201 | Engineering Graphics and Solid Modelling II | 3 | C | 30 | 45 |
| 2 | BUK-MEE 202 | Applied Mechanics | 3 | C | 30 | 45 |
| 3 | BUK-MEE 203 | Applied Electricity II | 2 | C | 15 | 45 |
|  | **Total** | | **8** |  |  |  |

**300 Level**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S/N** | **300 Level Course Code** | **Course Title** | **Credit** | **Status** | **LH** | **PH** |
| 1 | BUK-MEE 301 | Applied Thermodynamics I | 2 | C | 15 | 45 |
| 2 | BUK-MEE 302 | Applied Fluid Mechanics I | 2 | C | 15 | 45 |
| 3 | BUK-MEE 303 | Essentials of Metallurgy and Materials Engineering | 2 | C | 15 | 45 |
| 4 | BUK-MEE 304 | Machine Drawing | 2 | C | 15 | 45 |
| 5 | BUK-MEE 305 | Mechanics of Materials I | 3 | C | 30 | 45 |
| 6 | BUK-MEE 306 | Electrical Instrumentation and Measurement | 2 | C | 15 | 45 |
| 7 | BUK-MEE 307 | Engineering Metrology | 2 | C | 15 | 45 |
| 8 | BUK-MEE 308 | Analysis of Mechanisms and Machines | 2 | C | 15 | - |
| 9 | BUK-MEE 309 | Machine Tools and Processes | 2 | C | 15 | 45 |
| 10 | BUK-MEE 310 | Computer-Aided Design and Manufacture | 3 | C | 30 | 45 |
| 11 | BUK-MEE 311 | Engineering Mathematics IV | 3 | C | 45 | - |
| **Total** | | | **25** |  |  |  |

**400 Level**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S/N** | **400 Level Course Code** | **Course Title** | **Credit** | **Status** | **LH** | **PH** |
| 1 | BUK-MEE 402 | Balancing and Vibrations in Machines | 2 | C | 15 | 45 |
| 2 | BUK-MEE 403 | Applied Thermodynamics II | 2 | C | 15 | 45 |
| 3 | BUK-MEE 404 | Applied Fluid Mechanics II | 2 | C | 15 | 45 |
| 4 | BUK-MEE 405 | Heat and Mass Transfer | 3 | C | 30 | 45 |
| 5 | BUK-MEE 406 | Mechanics of Materials II | 2 | C | 15 | 45 |
| 6 | BUK-MEE 407 | Manufacturing Processes | 2 | C | 15 | 45 |
| 7 | BUK-MEE 408 | Product Design | 2 | C | 15 | 45 |
| **Total** | | | **15** |  |  |  |

**500 Level**

**Common Core Course**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S/N** | **500 Level Course Code** | **Course Title** | **Credit** | **Status** | **LH** | **PH** |
| 1 | BUK-MEE 502 | Turbomachinery and Reciprocating Engines | 3 | C | 30 | 45 |
| 2 | BUK-MEE 503 | Control System Engineering | 3 | C | 30 | 45 |
| 3 | BUK-MEE 504 | Engineering Management | 2 | C | 30 | - |
| **Total** | | | **8** |  |  |  |

**Optional Courses (To select three (3) courses from one specialization/option)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **ENERGY OPTION** | | | | | | |
| **S/N** | **500 Level Course Code** | **Course Title** | **Credit** | **Status** | **LH** | **PH** |
| 1 | BUK-MEE 505 | Refrigeration and Airconditioning | 3 | E | 30 | 45 |
| 2 | BUK-MEE 506 | Aerodynamics | 3 | E | 30 | 45 |
| 3 | BUK-MEE 507 | Design and Analysis of Thermal Systems | 3 | E | 45 | - |
| 4 | BUK-MEE 508 | Introduction to CFD | 3 | E | 30 | 45 |
| 5 | BUK-MEE 509 | Mechanical Building Services | 3 | E | 30 | 45 |
| 6 | BUK-MEE 510 | Advanced Control Systems Engineering | 3 | E | 30 | 45 |
| **Total (for the 3 Optional courses)** | | | **9** |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PRODUCTION OPTION** | | | | | | |
| **S/N** | **500 Level Course Code** | **Course Title** | **Credit** | **Status** | **LH** | **PH** |
| 1 | BUK-MEE 509 | Mechanical Building Services | 3 | E | 30 | 45 |
| 2 | BUK-MEE 510 | Advanced Control Systems Engineering | 3 | E | 30 | 45 |
| 3 | BUK-MEE 511 | Ergonomics and Work Design | 3 | E | 45 | - |
| 4 | BUK-MEE 512 | Surface Treatments and Coatings | 3 | E | 30 | 45 |
| 5 | BUK-MEE 513 | Advanced Manufacturing Processes | 3 | E | 30 | 45 |
| 6 | BUK-MEE 514 | Additive Manufacturing | 3 | E | 30 | 45 |
| 7 | BUK-MEE 515 | Theory of Elasticity | 3 | E | 40 | 45 |
| 8 | BUK-MEE 516 | Materials Characterization | 3 | E | 45 | - |
| 9 | BUK-MEE 517 | Mechanics Of Metal Forming | 3 | E | 30 | 45 |
|  |  |  |  |  |  |  |
| **Total (for the 3 Optional courses)** | | | **9** |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **APPLIED MECHANICS OPTION** | | | | | | |
| **S/N** | **500 Level Course Code** | **Course Title** | **Credit** | **Status** | **LH** | **PH** |
| 1 | BUK-MEE 509 | Mechanical Building Services | 3 | E | 30 | 45 |
| 2 | BUK-MEE 510 | Advanced Control Systems Engineering | 3 | E | 30 | 45 |
| 3 | BUK-MEE 516 | Materials Characterization | 3 | E | 45 | - |
| 4 | BUK-MEE 517 | Mechanics Of Metal Forming | 3 | E | 30 | 45 |
| 5 | BUK-MEE 518 | Fracture Mechanics | 3 | E | 30 | 45 |
| 6 | BUK-MEE 519 | Tribology | 3 | E | 30 | 45 |
| 7 | BUK-MEE 520 | Vehicle Dynamics | 3 | E | 30 | 45 |
| 8 | BUK-MEE 521 | Introduction to FEMs | 3 | E | 45 | - |
| **Total (for the 3 Optional courses)** | | | **9** |  |  | O |

**Summary of Credit Units Added**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Level** | **100** | **200** | **300** | **400** | **500** | **Total** |
| **Credits** | 4 | 8 | 25 | 15 | 8 | **60** |

**Summary of total credit units for all courses**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Level** | **100** | **200** | **300** | **400** | **500** | **Total** |
| **CCMAS credits** | 26 | 30 | 10 | 20 | 19 | **105** |
| **Added credits** | 4 | 8 | 25 | 15 | 8\* | **60** |
| **Total** | 30 | 38 | 35 | 35 | 27 | **165** |

\*This is for the core courses and the students **must attempt three** elective/optional courses (total of 9 credits) from one of the optional groups provided in Level 500. These elective/optional courses need not to be passed but **must be attempted** for graduation.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 102 General Physics III (Electricity & Magnetism) (2 Units; Core; L = 30)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals of physics and which will equip them with broad knowledge of Physics foundation and electronics to address the challenges of the 21st century, which is in agreement with BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce energy efficient electronic systems to address Africa’s energy challenges.

**Overview**

This course is design to provide basic foundation of Physics that is dealing with electricity and magnetism and underlining mathematical concepts that underpin a better understanding of the course.

The course is an introduction to electromagnetic fields and forces and the overall goal is to use the scientific method to come to understand the enormous variety of electromagnetic phenomena in terms of a few relatively simple laws.

**Objectives**

In this course students will learn to:

1. describe the ways in which various concepts in electromagnetism come into play in particular situations.
2. represent these electromagnetic phenomena and fields mathematically in those situations.
3. use Coulomb’s law, Gauss’s law, and electric potential to determine electrostatic properties of charge distributions for different applications.
4. explain the physical meaning and application of Maxwell’s equations.
5. discuss the DC circuits and the characteristics of AC systems.

**Learning Outcomes**

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

1. describe the electric field and potential, and related concepts, for stationary charges.
2. calculate electrostatic properties of simple charge distributions using Coulomb’s law, Gauss’s law, and electric potential.
3. describe and determine the magnetic field for steady and moving charges.
4. determine the magnetic properties of simple current distributions using Biot-Savartand Ampere’s law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz’s laws.
6. explain the basic physical of Maxwell’s equations in integral form.
7. evaluate DC circuits to determine the electrical parameters; and
8. determine the characteristics of AC voltages and currents in resistors, capacitors, and inductors.

**Course Content**

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb’s law and superposition. Electric field and potential. Gauss’s law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm’s law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère’s laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz’s laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

**Minimum Academic Standard**

General Physics III (Electricity & Magnetism) is as contained in the NUC CCMAS.

It requires Physics Practical Laboratory.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 103 General Physics IV (Vibration, Waves and Optics) (2 Units; Core; L = 30)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals of physics and which will equip them with broad knowledge of Physics foundation to address the challenges of the 21st century, which is in agreement with BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce energy efficient and sustainable energy systems to address Africa’s energy challenges.

**Overview**

This course is design to provide basic foundation of Physics that is dealing with vibration, waves and optics, and underlining mathematical concepts that underpin a better understanding of the course.

The course gives an overview and understanding of basic physics, with moderate use of mathematical formalism.

**Objectives**

In this course students will learn:

1. the basic principle of vibration.
2. what is meant by harmonic motion and its application.
3. the application of different wave propagation in sounds and light systems.
4. to use and apply geometrical optics for different application.
5. The principle of operation of optical instruments.

**Learning Outcomes**

On completion, the students should be able to;

1. describe and quantitatively analyze the behaviour of vibrating systems and wave energy;
2. describe simple harmonic motion.
3. explain the propagation and properties of waves in sound and light;
4. identify and apply the wave equations; and
5. explain geometrical optics and principles of optical instruments.

**Course Content**

Simple harmonic motion (SHM): energy in a vibrating system, Damped SHM, Q values and power response curves, Forced SHM, resonance and transients, Coupled SHM. Normal modes. Waves: types and properties of waves as applied to sound; Transverse and Longitudinal waves; Superposition, interference, diffraction, dispersion, polarization; Waves at interfaces; Energy and power of waves, the 1-D wave equation, 2-D and 3-D wave equations, wave energy and power, phase and group velocities, echo, beats, the Doppler effect, Propagation of sound in gases, solids and liquids and their properties.

**Minimum Academic Standard**

General Physics III (Electricity & Magnetism) is as contained in the NUC CCMAS.

It requires Physics Practical Laboratory.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 201 Engineering Graphics and Solid Modelling II (3 Units; Core; L = 30; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled in the use of drawings and software for the drafting of structures, machine components and their assembly. Students will be able to produce detailed engineering drawings using software from the design sketches. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can develop detailed drawings of machines and their components from design sketches which can be used for the manufacturing of the machines.

**Overview**

In this course, students will also acquire engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions and also the requisite knowledge, techniques and attitude required for advanced study of engineering drawings.

The students will learn solid, surface and shell modeling, material optimization and component assembly and motion constraints. They will also learn how to use 3-D printing, Laser cutting and CNC machinery as well as arrangement of engineering components to form a working plant.

**Objectives**

In this course students will learn to:

1. acquire drawing skill for drawing various object used in engineering drawing.
2. simulate and optimize design for material optimization.
3. to use 3-D printing, Laser cutting and CNC machinery.
4. use creativity and ability to innovate ideas in drawing.
5. create and produce shop drawings for multi-physical and multidisciplinary design.

**Learning Outcomes**

Students should be able to:

1. apply mastery of the use of projections to prepare detailed working drawing of objects and designs;
2. identify skills in parametric design to aid their ability to see design in the optimal specification of materials and systems to meet needs;
3. analyze and optimize designs on the basis of strength and material minimization;
4. create the basis for the analysis that are possible in design and optimization, and recognize/understand the practical link to excite their creativity and ability to innovate; and
5. be able to translate their thoughts and excitements to produce shop drawings for multi-physical, multidisciplinary design.

**Course Content**

Projection of lines, auxiliary views and mixed projection. Preparation of detailed working production drawing; semi-detailed drawings, conventional presentation methods. Solid, surface and shell modeling. Faces, bodies and surface intersections. Component-based design. Component assembly and motion constraints. Constrained motions and animation. Introduction to electronics modeling. Electronics board layout preparation, Component libraries and Schematic design. Parametric modeling and adaptive design. Simulation for material optimization. Designing for manufacturing. Additive and subtractive manufacturing. Production for 3-D printing, Laser cutting and CNC machinery. Arrangement of engineering components to form a working plant (Assembly Drawing of a Plant).

**Minimum Academic Standard**

Engineering Graphics and Solid Modelling II is as contained in the NUC CCMAS.

It requires Drawing and Design Studio: Adequate space and drawing boards are to be provided based on the population of students to be served. Students are to take off with exposure to drawing board practice to handle diverse drawing assignments. Such exposure is highly required notwithstanding the emergence of software packages for drawing such as Microsoft Visio and AutoCAD.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 202 Applied Mechanics (3 Units; Core; L = 30; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals of applied mechanics which is the science in which all design of machines is based on. It will equip them with the requisite skills for the analysis of the behavior of machines/structures subject to different forces at equilibrium and also how to convert one type of motion into another and conduct the kinematics and kinetic analysis of machines. It will also equip them This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that have the requisite scientific background knowledge/skills to design and analyse machines and structures to solve problems.

**Overview**

In this course students will learn how to analyse the behaviour of structural and machine components subjected to different loading and support conditions. It will expose the students to the concept of how motions are being converted from one type to the other which forms the basis for any machine.

Students will also learn how to analyzes the forces acting over bodies and the resulted motion, the fundamental principles and properties of the bodies like mass, moment, inertia, acceleration and reactions. They will also be able to learn concept of virtual work, degrees of freedom and potential energy.

**Objectives**

In this course students will learn to:

1. explain the basic concepts and system of forces.
2. discuss the relationship of physical process, kinetics and kinematics.
3. develop skills to use the basic principles of mechanics in engineering application
4. analyze the mechanism of friction in different systems such wedges, belt drives and screws.
5. apply the concept of virtual work, degrees of freedom and potential energy.
6. to use Newton’s second law and other laws of kinetics to solve problems.
7. to use newton’s second law, work-energy and impulse-momentum principles for the solution to problems in rigid body kinematics
8. anaylze velocity and acceleration vectors.

**Learning Outcomes**

The students should be able to:

1. explain the fundamental principles of applied mechanics, particularly equilibrium analysis, friction, kinematics and momentum;
2. identify, formulate, and solve complex engineering problems by applying principles of engineering, science, mathematics and applied mechanics;
3. synthesize Newtonian Physics with static analysis to determine the complete load impact (net forces, shears, torques, and bending moments) on all components (members and joints) of a given structure with a load;
4. Use the approach of absolute or relative motion in the analysis of rigid bodies in motion and simple mechanisms
5. Solve the velocity and acceleration equations using either scalar geometric analysis, vector algebra or graphical construction of the vector polygon.
6. Describe the motion of rigid bodies as translation, fixed-axis rotation or general plane motion
7. Apply newton’s second law, work-energy and impulse-momentum principles for the solution to problems in rigid body kinematics.
8. apply engineering design principles to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

**Course Content**

Forces. Moments. Couples. Equilibrium of simple structures and machine parts. Friction. First and second moments of area; centroids. Kinematics of particles and rigid bodies in plane motion. Newton's laws of motion. Kinetic energy and momentum analysis.

**Minimum Academic Standard**

Applied Mechanics course is as contained in the NUC CCMAS GET 207 Applied Mechanics course.

It requires Static and Dynamics Laboratories.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 203 Applied Electricity II (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled in electrical principles as they apply to power systems and electrical machines. It will equip them with the skills required for the design and operation of electrical Power Systems from power generation to distribution This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce energy efficient power systems and machines to address Africa’s energy challenges.

**Overview**

The focus of this course is to understand the magnetic field, the reluctance of magnetic materials and air. The voltage-current characteristics, voltage regulation of DC generators, torque speed characteristics, speed regulation of DC motors and the generalized concepts of electromechanical energy conversion are included in this course. Working principles, construction and operation of single phase and three phase transformers will be studied. This course includes AC machines fundamentals and production of rotating magnetic field. In this course working principles, construction, characteristics and equivalent circuit of three phase synchronous generators, synchronous motors and induction motors, Single phase and special purpose motors are discussed in detail.

The course is also an introductory subject in the field of electric power systems and electrical to mechanical energy conversion. Electric power has become increasingly important as a way of transmitting and transforming energy in industrial, military and transportation uses. Electric power systems are also at the heart of alternative energy systems, including wind and solar electric, geothermal and small scale hydroelectric generation.

**Objectives**

In this course students will learn to:

1. design and troubleshoot electronics and electrical circuits including electric power systems
2. explain the principle of operation and the effect of pulsating, rotating magnetic fields on the working of AC machines
3. discuss speed control methods and equivalent circuit diagram of poly phase and single phase machines.
4. explain the design and principle of operation of DC machines.
5. discuss the basic electrical Power Systems from power generation to distribution.

**Learning Outcome**

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

1. use computational tools and packages in the design of electric power systems, electronic, and digital equipment and systems;
2. solve common, technical problems in the design of electronics and electrical circuits including electric power systems, and seek specialist advice as needed for more complicated problems;
3. identify the process of innovation and the main factors of entrepreneurship and creative thinking, and apply methods of product development;
4. apply project management methods to the planning of projects;
5. plan, manage and analyse projects, using current best-practice methods; and
6. carry out a cost estimate for a design solution, and understand the uncertainties associated with the cost estimation process.

**Course Contents**

Power factor, Power in AC circuit, Resonance in RLC series and parallel circuit, Three Phase Circuits: Voltages of three balanced phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams. DC Machines: Construction, Basic concepts of winding (Lap and wave); DC generator: Principle of operation, EMF equation, characteristics (open circuit, load) DC motors: Principle of operation, Torque Equation, Speed Torque Characteristics (shunt and series machine); Single Phase Transformer: Constructional parts, Types of transformers, Emf equation, No Load no load and on load operation, phasor diagram and equivalent circuit, losses of a transformer, regulation and efficiency calculation; Three Phase Induction Motor: Types, Construction, production of rotating field, principle of operation, Slip and Frequency, rotor emf and current, Equivalent circuit and phasor diagram, Torque Slip characteristics torque-speed characteristics; General Structure of Electrical Power System: Power generation to distribution through overhead lines and underground cables with single line diagram, Earthing of Electrical Equipment, Electrical Wiring Practice.

**Minimum Academic Standard**

Applied Electricity II is as contained in part of the new NUC CCMAS Applied Electricity II.

Electrical Laboratory with DC, AC Motors, transformers

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 301 Applied Thermodynamics I (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals of energy analysis and which will equip them with the requisite skills for the development of energy, thermal and renewable energy systems which is in agreement with BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce energy efficient and sustainable energy systems to address Africa’s energy challenges.

**Overview**

The course is designed to expose students to the application of the laws of thermodynamics to the solution of Thermo fluid problems. Specifically, students will learn the application of the first law of thermodynamics to the analysis of Steady flow energy devices such as heat exchangers, nozzle, diffuser, turbine e.t.c, The analysis (determination of the performance and efficiency) of various steam and gas power cycles,.

This course will also equip students with the knowledge of determining thermodynamic properties, properties of mixtures and the determination of atmospheric properties such as relative humidity, specific humidity e.t.c which forms the basis for air-conditioning design.

**Objectives**

In this course students will learn to:

1. apply techniques required for the analysis and performance evaluation of various Rankine Power Cycles
2. apply techniques required for the analysis and performance evaluation of various Gas Power Cycles
3. apply techniques required for the analysis and performance of combined power cycles.
4. determine properties and perform energy analysis of non-reacting gas mixtures.
5. determine the properties of atmospheric air.

**Learning Outcomes**

On completion of the course, student should be able to:

1. Draw any power cycle on a chart (either T-S, P-V and e.t.c)
2. Apply the first law of thermodynamics to analyse and evaluate the performance of various steady flow energy devices such as heat exchangers, nozzle, diffuser, boiler, turbine, compressor and pump.
3. Analyse vapour power cycles (Rankine cycles) and determine how the thermal efficiency can be improved by modifying the basic Rankine cycle
4. Evaluate the performance of re-heat, regenerative, combined and binary power cycles.
5. Analyse and determine the performance of cycles in which the working fluid remains gas throughout the cycle (gas power cycles)
6. Classify gas power cycles and make simplifying assumptions in the analysis of gas power cycles
7. Carry out performance analysis on gas power cycles based on the Otto, Diesel and Brayton cycles
8. Classify IC engines based on the fuel or stroke and Explain their principle of operation
9. Explain how super and turbo charging effects engine performance
10. Compare the practical IC engine cycle with an air standard cycle
11. Obtain the properties of a mixture of gases (both ideal and real) from the properties of the individual gases
12. Apply the Dalton’s law and Amagat’s law to predict the P-V-T behaviour of gas mixtures.
13. Conduct energy analysis on a mixing process
14. Differentiate between atmospheric and dry air
15. Calculate relative humidity, specific humidity and dew point temperatures of atmospheric air
16. Relate adiabatic saturation temperature and wet bulb temperature
17. Use psychrometric chart as a tool to determine the properties of atmospheric air

**Course Content**

Application of first law to steady flow processes: Boilers and condensers. Turbines and compressors. Nozzle and Diffuser. Throttling valves. Isothermal steady flow processes. Vapor Power Cycles: The Carnot Cycle. The Rankine Cycle. Comparison of Cycles. The Reheat Cycle. The Regenerative cycle. The economizer and the air preheater. Gas Power Cycle: Internal combustion engines and air standard cycles. The simple gas turbine cycle. The jet engine. Reciprocating engine cycles: Otto and Diesel Cycles. Properties of Mixtures: Mixtures of gases. The mixing process. Gas and vapor mixtures. Hygrometry. Evaporative cooling.

**Minimum Academic Standard**

Applied Thermodynamics I is as contained in part of the new NUC CCMAS Applied Thermodynamics course.

It requires Thermodynamics laboratory with Steam power plant rig (vapour power cycle,). Steady flow devices

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 302 Applied Fluid Mechanics I (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals of fluid flow analysis and which will equip them with the requisite skills for the development of energy and renewable energy systems which is in agreement with BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce energy efficient and sustainable energy systems to address Africa’s energy challenges.

**Overview**

The course is design to help students to develop an understanding of sound engineering design of internal flow in pipes and to develop the problem-solving skills essential to good engineering practice in the fluid systems area.

Students will have the opportunity to demonstrate a familiarity and ability to work on flow of an incompressible fluids bounded by surfaces such as flow in pipes.

**Objectives**

In this course students will learn to:

1. Describe various kinematic elements of flow using the velocity field and understand the concepts of stream function and velocity potential.
2. Explain closed and open system. Analyze various fluid flow systems using the differential and control volume approaches.
3. Derive, apply and analyze laws of mass conservation and momentum conservation (Euler’s equation) for moving fluids.
4. Derive and apply Navier-Stokes equation to solve various hydrostatic problems. Use Navier-Stokes equation to analyze different fluid flow systems.
5. Identify various characteristics of internal flow in pipes and understand the main properties of laminar and turbulent pipe flows.
6. Estimate and analyze losses in straight portions of pipes (smooth and rough) and those in various pipe system components/fittings. Use of Moody Chart.
7. Apply appropriate equations and principles to analyze variety of pipe flow networks/situations. Design and select a pump for any fluid system.
8. Predict flowrate in pipes using the principles of common flowmeters. Design and create a simple viscous fluid flow meter.

**Learning Outcomes**

A student completing this course will be able to:

1. Explain and sketch the stream function and velocity potential of a particle in space.
2. Differentiate between a closed and open system and apply it to control volume formulations.
3. Use differential forms to derive the general formulation for the conservation of mass and conservation of momentum for an infinitesimal control volume from that of a finite control volume and be able to explain the meaning of each term.
4. Derive and apply correct assumptions to the Navier-Stokes equation to solve and analyze various hydrostatic and fluid flow problems.
5. Explain the concept of laminar and turbulent pipe flow and appreciate their differences.
6. Design, analyze, and create variety of pipe flow networks/situations. Design appropriate pump for different fluid flow applications.
7. Explain and apply basic concepts of flow meters to measure flow rates and be able to develop a common flow meter.

**Course Content**

**Fluid Kinematics:** Velocity Field: Eulerian and Lagrangian flow descriptions. Steady and Unsteady flows, One- and three-dimensional flows, Streamlines, streaklines and pathlines. Acceleration field. **Integral analysis for a control volume:** The continuity equation. Linear momentum equations (integral approach): Derivation and applications. The Energy equation: derivation, application, comparison with Bernoulli’s equation, combination of the energy equation with moment of momentum equation. **Differential analysis of fluid flow:** The continuity equation (differential form): polar coordinates, the stream function. Conservation of linear momentum. Invicid flow: Euler’s equation of motion, the Bernoulli equation, Irrotational flow, Bernoulli equation for irrotational flow, velocity potential. Flow superposition. Viscous flow: Stress Deformation relationships and the Navier stokes equations. **Viscous flow in pipes.** Characteristics of pipe flow: laminar and turbulent flow, Entrance region and fully developed flow. Friction factor. Pressure losses in pipes: major losses, minor losses and non-circular conduits. Pipe flow examples of single and multiple pipe systems. Applications. Pipe flow rate measurements.

**Minimum Academic Standard**

Applied Fluid Mechanics I is as contained in part of the new NUC CCMAS Applied Fluid Mechanics course. It requires fluid mechanics laboratory with apparatus for:

1. Laminar and turbulent flow in pipes
2. Friction loss in pipes
3. Apparatus for head losses in pipe fittings.
4. Flow visualization

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 303 Essentials of Metallurgy and Material Science (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled to select materials (metals, polymers, plastics and composite) for the production of machines and their components. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can select the best materials for the production of machines and their components.

**Overview**

In this course students will learn the production of Iron from its ore and the limitations of Iron that led to the development of steel and the various alloys of steel, Corrosion in ferrous materials, Selection of non-ferrous materials for engineering applications.

Students will also learn the engineering application of polymers, ceramic and glasses. In today’s world new materials are being produced to replace conventional materials, thus students will also learn the various techniques for the production of composite and nano-materials

**Objectives**

In this course students will learn to:

1. Identify and classify Iron and Steels and know the limitation of Unalloyed (Plain Carbon Steels)
2. Select non-ferrous metals, their alloys for different engineering applications
3. Explain the various isothermal transformation processes and determine the effect of cooling on the structure and properties of steel
4. Acknowledge the inevitability of corrosion as a process in engineering materials (especially metals), types of corrosions and preventions/methods of conditioning.
5. Classify and understand the engineering applications of polymers, ceramics and glasses.
6. Categorise and know the various techniques of production of composite and nano-composite materials with proposed strengthening/toughening mechanisms.

**Learning Outcomes**

On completion of the course, students should be able to:

1. Understand how Iron and Steels are produced and classified; charges, processing, product types; pig, wrought and cast irons, killed, semi-killed and rimmed steels, and shapes; slabs, blooms and billets.
2. Appreciate the role of the iron-carbon equilibrium diagram (the iron-iron-carbide phase diagram) in determining the structure/property relationship of iron and steel.
3. Identify the limitations of plain carbon steels (unalloyed steels) and how to mitigate these limitations.
4. Know the common non-ferrous metals, their alloys and engineering applications.
5. Differentiate between the non-equilibrium condition; strengthening/hardening and equilibrium conditions; softening/stress relieving; e.g. tempering, annealing, spheroidising, surface hardening and normalising in heat treatable carbon and alloy steels.
6. Acquit with various isothermal transformation processes and the effect the rate of cooling of steels on their structures and properties.
7. Acknowledge the inevitability of corrosion as a process in engineering materials (especially metals), types of corrosions and preventions/methods of conditioning.
8. Classify and understand the engineering applications of polymers, ceramics and glasses.
9. Categorise and know the various techniques of production of composite and nano-composite materials with proposed strengthening/toughening mechanisms.
10. Familiarise with the advantages of high surface area volume ratio obtainable in nano-materials; specifically graphene and carbon nanotube.

**Course Content**

**Iron and steel:** The manufacture of iron and steel---iron- carbon equilibrium diagrams - Alloy steels – stainless steels – Heat resisting steels. Wrought and cast irons. **Non-ferrous metals and alloys:** Copper and its alloys – aluminium and its alloys – other important alloys. **Heat treatment processes:** Stress relieving – Annealing – Normalizing – Tempering – Hardening – Core refining – isothermal transformation. Curves – Hardenability – mass effect – ruling section – age hardening of metals. **Corrosion of metals:** Types of corrosion – cause – prevention. **Other Engineering materials:** Polymers, Ceramics and Glasses: Classifications and applications. Composite and Nano-composite materials: Classifications, processing, strengthening and toughening mechanisms. Nanomaterials: Graphenes/Carbon nanotubes.

**Minimum Academic Standard**

It requires laboratory with the following:

(i) Furnace

(ii) Metallography

(iii) Optical microscope

(iv) Polishing machines

(v) Metallurgical microscope with camera

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 304 Machine Drawing (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled in the use of software for the drafting of machine components and their assembly. Students will be able to produce detailed engineering drawings using software from the design sketches. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can develop detailed drawings of machines and their components from design sketches which can be used for the manufacturing of the machines.

**Overview**

In this course, students will also acquire engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions and also the requisite knowledge, techniques and attitude required for advanced study of engineering drawings.

They will learn drafting standards, orthographic drawing, development, loci, cams and creation of 2-D drawings and 3-D solid models. They will also learn how to use of 2D and 3D CAD softwares (such as AUTOCAD, SolidWorks, CATIA e.t.c) for the drafting/drawing of mechanical engineering components and machine assembly.

**Objectives**

In this course students will learn to:

1. be proficient in the use of a CAD software for the 2D and 3D creation and modification of mechanical engineering components and machine assembly.
2. read and implements drawing standards, make orthographic projections of machine components, Loci and CAMS.
3. produce detailed drawings of machine and assembly drawings of components and applying the required standards, dimensioning, tolerances and surface finishes.
4. Produce quality engineering drawings of joints and fasteners.
5. communicate between Design and Manufacturing drawings.

**Learning Outcomes**

On completion of the course, Students will be able to:

1. Read and understand a drawing standards and use them to make orthographic drawings
2. Develop patterns of surfaces and their applications in sheet metal forming
3. Understand loci and their application in drawing of machine components/units such as link mechanism, involute gear tooth, threads etc.
4. Create and modify two-dimensional orthographic drawings using AutoCAD software, complete with construction lines, dimensions, and layers, conforming to industry standards.
5. Create three-dimensional solid models using AutoCAD software, and generate paper space layouts from model space geometry.
6. Students should be able to use and interpret standard conventions used in engineering drawing
7. Construct and present quality engineering drawings joints and gearing systems.
8. Analyze and apply standards, symbols and rules for dimensioning, tolerancing and surface finishing to detailed and assembly drawings.
9. Have skills to produce detail and assembly drawings using a CAD software.
10. Communicate between Design and Manufacturing using both 2D drawings and 3D drawings or models.

**Course Content**

***Drawing Standards/Convention:***Conventional representations/Schematic product symbols for standard machine components, Scales, Paper formatting, Projection Symbols, Planes of projection; Types of orthographic projection and symbols. ***Geometric and Dimensioning Tolerances:*** Limits, Fits, Dimensional Tolerances, Geometric Tolerances and surface finishes; ***Development of surfaces:*** Models and pattern making, applications of development in sheet metal forming. ***Loci:*** locus of points, mechanisms, involute, helix and cycloid. ***Cams*:** Types and applications, Graphical and synthesis methods of construction. ***Fastening/Joints:*** Bolt and Nut, riveted joint, welded joint; Gearing: Spur gears, Conventional representation and drawing; ***Machine Drawing:*** Conventional drawing of selected machine parts/elements involving Detail Drawing of machine components and Assembly Drawing of machine units such as a simple gear box, flange coupling, welded bracket etc. ***Computer Aided Machine Drawing:*** *Detail drawing using CAD software*: Drawing of 2-D or 3-D models of machine parts using CAD software. *Assembly drawing using CAD software:* Orthographic and isometric view of machine assembly; Preparation of part list; Individual drawing assignments using CAD software.

**Minimum Academic Standard**

Drawing and Design Studio: Adequate space and drawing boards are to be provided based on the population of students to be served. Students are to take off with exposure to drawing board practice to handle diverse drawing assignments. Such exposure is highly required notwithstanding the emergence of software packages for drawing such as Microsoft Visio and AutoCAD.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 305 Mechanics of Materials I (3 Units; Core; L = 30; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals of solid mechanics which is the science in which all design of machines is based on. It will equip them with the requisite skills for the analysis of the behavior of machines/structures subject to different loadings. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that have the requisite scientific background knowledge/skills to design/analyse machines and structures to solve problems.

**Overview**

In this course students will learn how to analyse the behaviour of structural and machine components subjected to different loading and support conditions in more than one dimension. This will form the fundamentals/applied science for the design of components later.

Students will also learn to analyse structural members subjected to loading beyond their Elastic limits (plastic deformation). They will also be able to analyse forces in statically indeterminate structures and design pressure cylinders (thick and compound cylinders).

**Objectives**

In this course students will learn to:

1. develop the technical knowledge and skills required to analyse the behaviour of structural and machine components subjected to various loading and support conditions.
2. Evaluate the relationship between stress and strain in planes and thermal effects.
3. Analyse/Design Thick and Compound Cylinders
4. use Lame’s theorem to design and analyze pressurized cylinders.
5. Analyse structural members beyond their elatic limit (Inelastic and plastic cases)

**Learning Outcomes**

On completion of the course, students should be able to:

* 1. Apply the principles of equilibrium and material constitutional relationship to determine the behaviour of structural and machine components subjected to various loading and support conditions.
  2. Apply the concept of stress and strain to analyze structural members and machine parts under axial load, shear load, bending moment and torsion.
  3. Solve practical problems through evaluating the relationship between stress and strain.
  4. Determine stresses in inclined planes of a loaded member
  5. Determine principal stresses and strains in planes
  6. Determine the thermal effects.
  7. Calculate stresses due to combine stresses in a structural machine component.
  8. Analyse a structural member and machine part when loaded beyond its elastic limit (inelastic and plastic cases).
  9. Apply Lame’s theorem in the structural analysis/design of pressurized cylinders
  10. Analyse the forces in a statically-indeterminate beams.
  11. Use strain gauges for the measurement of strains in a loaded member.

**Course Content**

**Plane stress:** Stresses on incline planes, Transformation equations for plane stress, Principal stresses and Maximum shear stress, Mohr’s circle, Hooke’s law for plane stress, strain energy in plane stress. **Plane strain:** Plane strain versus plane stress, transformation equations for plane strain, principal strain, maximum shear strain, Mohr’s circle for plane strain, strain measurements. Thermal effects and combined stresses. **Thick cylinders;** Lame’s theory; Force fits; compound cylinders. **Beam Deflection Statically indeterminate beams**.

**Minimum Academic Standard**

It requires laboratory with the following:

(i) Apparatus for tensile, compression and torsion tests.

(ii) Simple bending apparatus.

(iii) Unsymmetrical bending apparatus.

(iv) Impact tests apparatus.

(v) Elastic behaviour of thin- and thick-walled pressure vessels.

(vi) Creep and fatigue.

(vii) Theories of failure.

(viii) Helical springs.

(ix) Deflection of curved beams.

(x) Columns and struts.

(xi) Strain gauging, photo-elastic behaviour.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 306 Electrical Instrumentation and Measurement (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled in electrical principles as they apply to the measurement and instrumentation in a machine or a production process. It will equip them with the skills required for the measurement of physical parameters and to acquire data from a machine assembly, experimental set up or a production process. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can understand and utilize the electrical instrumentations in a machine or a production process which will help them in working properly with electrical engineers.

**Overview**

Mechanical Engineering students will be exposed to the principles of electrical engineering for the measurement of physical parameters, design of sensors and actuators for data acquisition.

It will also expose students to the use different type of sensors for measurements such as temperature and speed/velocity.

**Objectives**

In this course students will learn to:

* 1. Explain the working principles of various measuring instruments and select them for appropriate applications.
  2. Explain the working principles of Mechanical, Thermal and Light Sensors
  3. calibrate measuring instruments.
  4. Use DC motor as an actuator.
  5. Design a data acquisition system using a micro controller for the data collection of various physical parameters such as temperature, speed e.t.c

**Learning Outcomes**

On completion of the course, students will be able to:

1. Explain the working principles of measuring instruments
2. Identify and select measuring instruments for a specific application
3. Carryout error analysis and calibrate a measuring instrument
4. Model fundamental physical and technical base of sensors and DC motors.
5. Design signal conditioning circuits for thermal, mechanical and light sensors
6. Identify and explain the different types of Electrical motors used for actuation
7. Identify various components of a Data Acquisition System
8. Develop a Data Acquisition System using a micro controller to acquire and log input/output data from a system or an experimental set-up

**Course Content**

**Measurement Methods:** Analogue techniques, comparison techniques, substitution methods, null methods. Input Characteristics- sensitivity, scaling, and matching. *Accuracy:* Values and uncertainty, precision, errors, summation of errors, random errors. Specifications and standards. Calibration Procedures. *Wave-form:* Sine wave, mean value, RMS value, Form Factor and crest factor, phase relationships, Bias, Harmonics, Frequency Effects, Bandwidth, Rise time. Interference: Environmental and coupled. **Mechanical sensors:** Explain the characteristics of various types of mechanical sensors, including the strain gauge, the linear variable differential transformer, and the variable area/distance capacitive transducers. Describe the operation of digital encoders, proximity sensors, and ultrasonic sensors. Design signal-conditioning circuits for mechanical sensors. **Thermal sensors:** Explain the characteristics of thermal sensors and transducers like the thermistor, the resistance-temp detector, the thermocouple, and the bimetal strip. Design signal-conditioning circuits for thermal sensors. **Light Sensors:** Describe the construction and characteristics of light sensors and transducers, including the photo-conductive cell, the photodiode, the photo transistor, and the photovoltaic cell. Design signal-conditioning circuits for light sensors. **Electrical Actuators:** Electrical Motors, basic principles and their types (DC and AC motors), Motor Equations, Drivers, and Control of DC Motors and Stepper Motors. Servo motors. Motor selection. **Data Acquisition System:** Data Acquisition system components, Analog input and outputs, Digital Input and output, DAC and ADC conversions

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 307 Engineering Metrology (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled in the use of various principles and equipment for the mechanical measurement of physical parameters (linear, angular, surface finish e.t.c) in a machine assembly or a production process. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce machines and their components that have satisfied the dimensional, tolerances and surface finish requirements in the design.

**Overview**

Students will be exposed to the standards of measurement and various techniques used for linear and angular measurements in production.

Students will learn how to measure machine components such as screw threads, gears and surface finish.

**Objectives**

In this course students will learn to:

1. Explain the standards of lengths and angles.
2. Use precision instruments to inspect engineering components
3. Explain the principles and applications of measuring instruments and gauges
4. Design tolerances and fits for a selected product quality
5. Determine surface roughness
6. Select appropriate methods and instruments for gear and thread measurements.

**Learning Outcomes**

On completion of the course, students should be able to:

1. Differentiate between Accuracy and Precision
2. Explain the standards of lengths and angles.
3. Use precision instruments to inspect engineering components
4. Explain the principles and applications of measuring instruments and gauges
5. Use slip & block gauges and Angle gauges for linear and angular measurements
6. Design tolerances and fits for a selected product quality
7. Determine surface roughness
8. Select appropriate methods and instruments for gear and thread measurements.
9. Design comparators.
10. Design inspection gauges and calibrate measuring instruments
11. Apply measurement methods (Peak to Valley, R. M. S. and C. L. A.) to determine surface finish of machine components

**Course Content**

**Accuracy:** Conditions for accuracy. Types of error. The effect of averaging results. The evolution of a length standard. Interferometry applied to flatness testing. The N.P.L. flatness interferometer. The pitter - N.P.L. Gauge Interferometer. **Linear Measurement:** Slip and block gauges. Length bars. Design and operation of linear measurement instruments (i.e. "effects of" Principles of alignment, sensitivity, accuracy, variances and inertia of moving parts). Principles of kinematics (complete constraint and one degree of Freedom). Design of comparators. High-magnification gauge comparators. (Brookes level comparator and the Eden-Rott `Millionth' comparator). **Angular Measurement and Circular Division:** Protractors, Sine bars. Angle gauges. Levels, Clinometers. Autocollimators and Angle Dekkors. Reflectors and optical square. Calibrating circular divided scales and indexing equipment, Precision Polygons and their calibration. Testing straightness, flatness and squareness. Taper measurement. **Screw Thread Measurement:** Types of Thread. Thread measurement. Errors in Thread. Thread gauges. **Gear Measurement:** Pitch measurement. Tooth thickness measurement, etc. **Measurement of Surface Finish:** Methods of measurement (Peak to Valley, R.M.S., and C.L.A.). Effect of sampling length, Measuring Instruments.

**Minimum Academic Standard**

It requires laboratory with the following:

(i) Taysurf surface roughness measurement apparatus

(ii) Slip gauges

(iii) Tool makers microscope

(iv) Micometer screw gauge

(v) Autocollimator

(vi) Angle dekko

(vii) Thread profile projector

(viii) Comparators

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 308 Analysis of Mechanisms and Machines (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled the motion analysis of machines and their mechanisms. It will equip them with the requisite skills to convert one type of motion into another and conduct the kinematics and kinetic analysis of machines which is one of the fundamental elements of the design process. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can synthesis (produce) various types of mechanisms alongside their kinetic analysis which is one of the requirements for the selection of machine elements in a machine

**Overview**

In this course students will be exposed to the concept of how motions are being converted from one type to the other which forms the basis for any machine. Since without motion there is no machine.

In machines forces and motion are being transmitted and there is the need to know force transmitted from one part of the machine to the other as well as the velocities and accelerations of different machine elements linked to one another in a machine.

Specifically, students will learn to:

1. apply mechanics principles in the kinematic and kinetic analysis/design of planar mechanisms and machines.
2. Analyze reciprocating engines to determine torque diagrams and design flywheels.
3. Describe static and dynamic force analysis on a single and multi-cylinder reciprocating engines including the design of flywheels.
4. design special mechanisms such as CAMS and Governors
5. The dyamic design and selection of various power transmission devices will be covered which include universal joints, Gearing systems, friction clutch e.t.c.

**Objectives**

On completion of the course, students should be able to:

1. Apply mechanics principles in the analysis (velocity, acceleration and force) of planar mechanisms and machines
2. Synthesize mechanisms (determine the lengths of the various links in a mechanism to perform its function)
3. Carryout static and dynamic force analysis on a single and multi-cylinder reciprocating engines including the design of flywheels.
4. Analyse special mechanisms such as CAMs, and Governors
5. Analyse and design power transmission machine elements such as universal joints, gearing systems, friction clutch and brakes.

**Learning Outcomes**

On completion of the course, students should be able to:

1. Determine the no. of degrees of freedom of a planar mechanisms
2. Determine the velocities and accelerations of various points/links in a planar mechanism including members with sliding and rotation using either vector method, analytical or graphical methods
3. Apply D’Alemberts principle in the force analysis of planar mechanisms and machines using either the vector method or graphical method
4. Determine input torques required to operate a mechanism
5. Calculate and represent dynamic forces acting on a link in a mechanism
6. Determine the lengths of the various links in a planar mechanism to perform its function (Mechanism synthesis)
7. Carry out force analysis on a piston and cylinder engine to determine the various forces/torques acting on an engine
8. Interprete torque diagrams and use them to design a suitable flywheel
9. Analyse cams and Governors
10. Determine characteristics of different governors and Select a Governor suitable for an application
11. Classify and analyse cams based on shape and motion of follower.
12. Determine max. velocities and acceleration of basic CAMS and those with specified contours (circular arc, tangent, rigid eccentric CAMS
13. Carry-out dynamic analysis of various power transmission mechanisms such as Hooke’s Universal Joint, Gearing systems and Friction Clutch

**Course Content**

**Mechanisms:** Introduction to mechanisms and machines. Velocity and Acceleration Analysis of mechanisms. Synthesis of simple mechanisms. Force Analysis of mechanism: Static and Dynamic force analysis in machinery, Torque diagram and Flywheel. **Power transmission:** Hookes Universal Joint. Gearing systems: simple and compound gear trains, epicyclic gears. Friction clutch, Gyroscopic effect and Euler’s equation. **Special Mechanisms:** **Cams:** Types of cam and Followers, Follower Motion, Cam profiles, Analysis of cams with specified contours. **Governors:** Types, Analysis of Centrifugal and Inertia Governors, Sensitivity, Effort and Power of a Governor.

**Minimum Academic Standard**

It requires laboratory with the following:

(i) Free oscillation of point and distributed masses (Simple and Compound Pendulum).

(ii) Model of Mechanisms (Whitworth, Slotted Link Slider-crank, Scotch Yoke, Geneva Stop, etc.)

(iii) Power transmission systems (Belts, Gears, Shafts and Clutches).

(iv) Coefficient of friction apparatus (Belt Drive, Slipping Friction).

(v) Free and forced vibration of single degree of freedom systems with and without damping.

(vi) Static and dynamic balancing systems.

(vii) Power regulation (by Flywheel and Governors).

(viii) Demonstration of coriolis and centrifugal forces.

(ix) Gyroscopic motion.

(x) Journal bearings

(xi) Vibration and noise test set up

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 309 Machine Tools and Processes (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled the use of machine tools for the production of machines and their components. It will equip them with the requisite skills to cut materials into the desired shapes for the production of machines . This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that produce machines and their components from design meaning turn raw materials using machining to finished products.

**Overview**

In this course, students will be exposed to the fundamental principles and the various processes involved in shaping metals into desired engineering shapes. They will learn the principles of material removal which is called machining and the various cutting processes, and the machines used in producing desired shapes from a solid material (machine tools). These machine tools include lathes, milling machine tools, grinding machine tools, drill presses.

The students will be introduced to the Computerised Numerical Control (CNC) Machine tools.

**Objectives**

In this course students will learn to:

1. explain the cutting tool geometry, mechanism of chip formation and mechanics of orthogonal cutting
2. Identify basic parts and operations of conventional machine tools including lathe, drilling, milling, grinding machine tools etc.
3. Select a machining operation and corresponding machine tool for a specific application
4. discuss the principles and operation of CNC machine tools
5. use a CNC machine to produce machine parts.

**Learning Outcomes**

On completion of the course, student will be able to:

1. Explain the geometry of a cutting tool, mechanism of chip formation and machinability and the mechanics of orthogonal cutting
2. Identify the various cutting parameters for a machining operation
3. Determine and optimise cutting parameters in a machining operation
4. Identify basic parts and operations of conventional machine tools including lathe, drilling, milling, grinding machine tools etc.
5. Select a machining operation and corresponding machine tool for a specific application
6. Select a micro-finishing operation (honing, lapping, and super finishing) suitable for a machine component
7. Produce a mechanical component that satisfy all the design and manufacturing requirements.
8. Explain the various non-traditional machining operations
9. Explain the principles and operation of CNC machine tools
10. Produce a simple machine component using a CNC Machine tool

**Course Content**

*Machining*; mechanics, Tool materials, Temperature, Cutting Forces, Wear and Tool Life considerations, tool geometry and chip formation, machinability, optimization of cutting parameters; *Finishing*: micro-finishing operations like honing, lapping and super-finishing. *Non-traditional machining*: EDM, ECM, USM, PAM, EBM, AJM, WJM, Explosive forming and LBM. *Machine Tools:* generation and machining principles, operations on machines viz. lathe, milling, drilling, grinding and gear cutting machines; *CNC machine tools* and emerging areas in machining technology.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 310 Computer-Aided Design and Manufacture (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals of energy analysis and which will equip them with the requisite skills for the development of energy, thermal and renewable energy systems which is in agreement with BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce energy efficient and sustainable energy systems to address Africa’s energy challenges.

**Overview**

The course is designed to expose and train the students to the use of CAD/CAM knowledge and tools to design, analyze and develop models and manufacture mechanical parts/components.

Students will learn how to the basic concepts of CNC programming and machining and write CNC programmes using Manual part programming, computer assisted programming and CAD/CAM programming.

**Objectives**

In this course students will learn to:

1. take active role in product design and development process as well as protptyping
2. model 3D part and assemblies using SolidWorks program
3. analyze the part design using one of the computational methods (e.g. stress analysis)
4. explain the concepts of computer-aided manufacturing and a number of applied associated processes
5. Describe the basic concepts of CNC programming and machining and write CNC programmes using Manual part programming, computer assisted programming and CAD/CAM programming.

**Learning Outcomes**

Upon successful completion of this course the student will be able to:

1. Explain the concepts and theory of modeling and the usage of models in different engineering applications.
2. Create geometry of complex mechanical engineering systems and use the geometric models in different engineering applications.
3. Explain the basic concepts of CNC programming and machining and write CNC programmes using Manual part programming, computer assisted programming and CAD/CAM programming.
4. Explain concept of PLC and programming of PLCs
5. Explain basic concept of Robotics and Robot programming
6. Create 3D models for rapid prototyping and process files for 3D printing.

**Course Content**

Computer Aided Drafting, Computer Aided Design and Analysis, Design optimization; Programmable Logic controllers (PLC) and their programming. Basic Concepts of Robotics, Robotics programming; NC and CNC machines and Programming of Numerically Controlled Machines. Rapid Prototyping (3D printing, etc). Laboratory practice using AUTOCAD and PRO-ENGINEER/SOLID WORKS for computer-aided drafting and design analysis. CNC part programming (Manual part programming, computer assisted programming and CAD/CAM programming) to manufacture selected jobs using CNC machines.

**Minimum Academic Standard**

Computer-Aided Design and Manufacture is as contained in the NUC CCMAS Computer-Aided Design and Manufacture course.

It requires the following:

1. Computer Lab - Computer Aided Design:

(i) Computation tool on finite elements such as CATIA; NASTRAN; ABAQUS; IDEAS;

MATLAB; ANSYS, PDMS

(ii) Workstations (at least one (1) workstation to five (5) students)

(iii) Printer

(iv) Multimedia facilities

(v) Most importantly the laboratory is expected to install software packages such as AutoCAD for drawing and other specialized packages for virtual laboratory.

1. Computer Aided Manufacture: CNC machines (lathe, milling, drilling, etc.)

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 311 Engineering Mathematics IV (3 Units; Core; L = 30; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in mathematical reasoning and problem–solving through the use of logic and computational skills which is in agreement with BUK’s mission to address African developmental challenges by producing mechanical engineering graduates with problem solving-skills in the area of technological advancement which is currently a global trend.

**Overview**

The course is designed to develops in students’ self-confidence in handling problems with minimal or no supervision. Students will acquire sufficient knowledge to develop confidence in appreciating and solving problems in general.

The course also provides students with the tools necessary to solve differential equations and application problems modeled by them. Every application and differential equation present its own challenges, but there are various classes of differential equations, and for some of these there are established approaches and methods for solving them.

**Objectives**

In this course students will learn to:

1. evaluate first order differential equations including separable, homogeneous, exact, and linear.
2. solve second order and higher order linear differential equations.
3. create and analyze mathematical models using higher order differential equations to solve application problems such as harmonic oscillator and circuits.
4. solve linear systems of ordinary differential equations
5. solve linear Partial Differential equations with different methods.
6. use technique of separation of variables to solve PDEs and analyze the behavior of solutions in terms of eigen function expansions.

**Learning Outcomes**

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

1. solve second order differential equations;
2. solve partial differential equations;
3. solve linear integral equations;
4. relate integral transforms to solution of differential and integral equations;
5. explain and apply interpolation formulas; and
6. apply Runge-Kutta and other similar methods in solving ODE and PDEs.

**Course Contents**

Series solution of second order linear differential equations with variable coefficients. Bessel and Legendre equations. Equations with variable coefficients. Sturn-Louville boundary value problems. Solutions of equations in two and three dimensions by separation of variables. Eigen value problems. Use of operations in the solution of partial differential equations and Linear integral equations. Integral transforms and their inverse including Fourier, Laplace, Mellin and Handel Transforms. Convolution integrals and Hilbert Transforms. Calculus of finite differences. Interpolation formulae. Finite difference equations. Runge-Kutta and other methods in the solutions of ODE and PDEs. Numerical integration and differentiation.

**Minimum Academic Standard**

Engineering Mathematics IV is as contained in the NUC CCMAS.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 402 Balancing and Vibrations in Machines (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled in balancing and vibration analysis of machines and their mechanisms. It will equip them with the requisite skills to design or modify a machine to reduce unbalance to acceptable limits and develop models for vibrating systems which is one of the fundamental elements of the design process of machines. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can synthesis (produce) various types of systems and mechanisms that are stable with minimal vibrations which is one of the requirements for the design of machines.

**Overview**

The course is designed to expose students to the modeling and analysis of vibration characteristics of mechanical systems with single degree and multiple degrees of freedom. Vibration control by isolation, absorption, and balancing.

Students will be able to model elements including mass/inertia, spring and damper elements and their corresponding describing equations. Furthermore, harmonically excited vibrations with many practical application problems; resonance and its physical significance are studied.

**Objectives**

In this course students will learn to:

1. Understand the process of designing or modifying a machine to reduce unbalance to acceptable limits and develop models for vibrating systems.
2. model and analyze vibration of mechanical systems with single degree and multiple degrees of freedom.
3. balance locomotives, V-engines, and radial engines
4. derive equations describing free vibrations of undamped and damped systems.
5. find whirling speeds for shafts and analyze torsional vibration.

**Learning Outcomes**

The student should be able to:

1. Apply mechanics principles to balance static masses in the same or different planes
2. Apply force analysis principles to dynamically balance rotating systems with masses in different planes.
3. Dynamically balance forces on a linkage, and systems with reciprocating masses.
4. Balance locomotives, V-engines, and radial engines.
5. Use balancing machines to determine static and dynamic unbalance in systems.
6. Identify various types of vibrations.
7. Determine natural frequencies, displacements, velocities and accelerations of vibrating systems by using either Equilibrium method, Energy method or Rayleih’s method.
8. Analyse Damping applied to vibrating systems.
9. Classify various ways of forcing a system to vibrate.
10. Analyse forced vibrations in systems to determine vibration parameters such as amplitude, resonance and e.t.c.
11. Determine the whirling speeds for shafts.
12. Determine vibration parameters for a system undergoing torsional vibration.

**Course content**

**Kinetics of rotating and reciprocating masses:** Static and Dynamic balance. Reciprocating engine balancing. **Mechanical Vibration:** Introduction, Degrees of Freedom. **Vibrations of Linear System with one degree of Freedom:** Undamped free and forced vibration, Damping (viscous), Damped free and forced vibration, Vibration isolation and transmitted force, The centrifugal pendulum, Torsional damped vibration at critical speed. **Vibration of Linear System with Two or More degrees of Freedom:** Equations of motion and solution. Undamped free and forced vibrations. Dynamic vibration absorber. Transmission of force and motion. **Torsional Vibration:** Discrete systems. Undamped free and forced torsional vibration. Oscillation of geared systems. **Transverse Vibration:** Natural frequency of distributed system in transverse vibration whirling shafts. Exact and approximate method. **Introduction to Non-linear Vibrations.**

**Laboratory Experiments:**

Static and dynamic balancing

Whirling vibration

Torsional stiffness of a shaft

Variation of undamped natural frequency

Free vibration

Forced vibration

Practical vibration and shock measurement

**Minimum Academic Standard**

Balancing and Vibrations in Machines is as contained in the NUC CCMAS Theory (Mechanics) of Machines I course.

It requires dynamics laboratory with vibration equipment.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 403 Applied Thermodynamics II (Principle of Combustion and Refrigeration & Airconditioning) (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals of energy analysis and which will equip them with the requisite skills for the development of energy, thermal and renewable energy systems which is in agreement with BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce energy efficient and sustainable energy systems to address Africa’s energy challenges.

**Overview**

The course is designed to expose students to the application of the laws of thermodynamics to the solution of thermos-fluid problems. Specifically, students will learn the application of energy balance to steady-flow and closed reacting (Combustion) systems to determine the amount of heat obtainable from these systems principles of combustion.

This course will also aquant students with the knowledge of determining refrigeration and air-conditioning load for refrigeration and air-conditioning systems.

**Objectives**

In this course students will learn to:

1. thermodynamically analyse combustion systems.
2. air-fuel ratio, percent theoretical air, and dew point temperatures used in combustion
3. obtain unmeasurable thermodynamic properties from those that are easily measurable.
4. apply thermodynamic principles to design and analyse refrigeration and air-conditioning systems.
5. Use Maxwell’s equation to develop general relations for Specific heats, internal energy, enthalpy and entropy changes for pure substances

**Learning Outcomes**

At the end of the course the student is expected to be able to:

1. Apply the principles of the laws of conservation of mass and energy to various air-conditioning processes.
2. Classify various types of fuel
3. Identify and determine parameters used in combustion analysis: air-fuel ratio, percent theoretical air, and dew point temperatures
4. Balance combustion equations by applying the principle of mass conservation
5. Determine the air-fuel ratio of an actual combustion process using the exhaust gas analysis
6. Apply energy balance to steady-flow and closed reacting (Combustion) systems to determine the amount of heat obtainable from these systems
7. Determine the enthalpies of reaction and combustion and heating values of fuels and the adiabatic flame temperature for reacting systems
8. Design combustion systems
9. Develop the Maxwell’s relations
10. Determine the enthalpy of vaporization of a substance using P, V and T measurements by applying the Clapeyron equation.
11. Apply the Maxwell’s equation to develop general relations for Specific heats, internal energy, enthalpy and entropy changes for pure substances.
12. Determine the performance of refrigerators and heat pumps
13. Perform the analysis of ideal, actual actual vapour compression refrigeration cycles
14. Analyse gas cycle refrigeration systems and liquefaction of gases
15. Determine the performance of absorption refrigeration system
16. Use psychrometric chart as a tool to determine the properties of atmospheric air
17. Determine refrigeration and air-conditioning load for refrigeration and air-conditioning systems
18. Use the psychrometric chart to analyse air conditioning processes
19. Design an air-conditioning system for a particular application

**Course Content**

**Principles of Combustion:**

Fuels, The chemical equation of Combustion. Analysis of theoretical (stoichiometric) and actual (Exhaust gas analysis) of combustion processes. Application of the First Law to combustion. Energy released by combustion. Flame temperatures. Dissociation. The Van't Hoff equilibrium. Thermodynamic Property Relations:Properties to be related. Exact differentials. Some general thermodynamic relatives. Processes undergone by solids and liquids. Availability and the Gibbs function. Availability as a criterion of cycle performance. **Refrigeration and Air Conditioning:**

Refrigeration Cycles: The reversed Carnot cycle. The mechanical vapor compression cycle. The absorption refrigeration cycle. Air cycle refrigeration. Heat pumps. Refrigeration Loads: Convected heat. Product load. Infiltration and ventilation effects. Radiation effects. Properties of Refrigerants: Toxicity, inflammability, chemical activity, odor and oil solvent properties, Thermodynamic characteristics. Refrigeration Compressors: Reciprocating and rotary types. Hermetically sealed compressors. Lubrication. Fans. Air-conditioning: Review on gas and vapour mixtures, the properties of atmospheric air, dehumidification and humidification. Water injection. Steady injection. Mixing and adiabatic saturation with reheat. Human comfort and design of air-conditioning processes. Environmental influences on comfort. Environmental refreshness.

Airconditioning Loads: The metabolic rate. Bodily mechanisms of heat transfer. Estimating air-conditioning loads. Sizing of air-conditioning equipment.

**Laboratory Experiments:**

1. The bomb calorimeter
2. Thermo-electric heat pump
3. Mechanical heat pump

**Minimum Academic Standard**

Applied Thermodynamics II (Principle of Combustion and Refrigeration & Airconditioning) is as contained in part of the new NUC CCMAS Applied Thermodynamics course.

It requires thermodynamics laboratory with the following equipment:

1. The bomb calorimeter
2. Thermo-electric heat pump
3. Mechanical heat pump

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 404 Applied Fluid Mechanics II (External and Compressible Flow) (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals of fluid flow and which will equip them with the requisite skills for the development of aerodynamics and fluid machineries for renewable energy systems which is in agreement with BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce energy efficient and sustainable energy systems to address Africa’s energy challenges.

**Overview**

The course is design to help students to develop an understanding of sound engineering design of external flows and to develop the problem-solving skills essential to good engineering practice in the fluid systems area.

Students will have the opportunity to demonstrate a familiarity and ability to work on external flow past a variety of objects and compressible (variable density) flow through or over bodies.

**Objectives**

In this course students will learn to:

1. analyse external flow past a variety of objects and compressible (variable density) flow through or over bodies.
2. discuss the fundamental characteristics of a boundary layer, including laminar, transitional, and turbulent regimes.
3. Describe the principle of boundary layer paremeters and boundary layer separation.
4. Identify Various features of different categories of compressible flows of ideal gases.
5. Analyse useful problems involving isentropic and nonisentropic flows including flows across normal shock waves.
6. analyze the lift and drag forces for various objects.

**Learning Outcomes**

After successful completion of this course, the student should be able to:

1. identify and discuss the features of external flow.
2. explain the fundamental characteristics of a boundary layer, including laminar, transitional, and turbulent regimes.
3. calculate boundary layer parameters for flow past a flat plate.
4. explain the concept of boundary layer separation.
5. calculate the lift and drag forces for various objects.
6. distinguish between incompressible and compressible flows, and know when the approximations associated with assuming fluid incompressibility are acceptable.
7. identify the features of different categories of compressible flows of ideal gases.
8. explain speed of sound and Mach number and their practical significance.
9. apply fluid dynamic principles to solve problems involving isentropic and nonisentropic flows including flows across normal shock waves.
10. appreciate the compelling similarities between compressible flows of gases and open channel flows of liquids.
11. determine the temperature and pressure of high speed gas flows

**Course Content**

**Flow Over Immersed bodies:** Introduction: lift and drag concepts, characteristics of flow past an object. Reynold's modification of Navier-Stokes equations. Turbulent mixing process. Boundary layer characteristics: Boundary layer structure and thickness over a flat plate, exact and approximate solutions, momentum integral boundary layer equation for flat plate, transition from laminar to turbulent flow, turbulent boundary layer on a flat plate, boundary layer separation, momentum integral boundary layer equations with non-zero pressure gradient. Drag: Friction and pressure drag. Lift. **Gas Dynamics:** Ideal gas relationships. Speed of sound and Mach number. Compressible flow regimes. Concept of static and total conditions. Isentropic flow of an ideal gas: effect of varying cross-sectional area, convergent-divergent duct, constant area duct. Non-isentropic flow of an ideal gas: Adiabatic constant area duct flow with friction (Fanno Flow) and Frictionless constant area duct flow with heat transfer (Rayleigh flow). Show waves: Attached and detached shock waves: Normal, Oblique and Bow shock waves. Prandtl-Meyer flow. Shock expansion theory. Temperature measurement in high speed gas flows. Pitot-tube in compressible flow.

**Minimum Academic Standard**

Applied Fluid Mechanics II (External and Compressible Flow) is as contained in part of the new NUC CCMAS Applied Fluid Mechanics course.

It requires fluid mechanics laboratory with the following;

1. Flow visualisation apparatus
2. Apparatus for flow of fluid round bodies
3. Subsonic wind tunnel and accessories
4. Supersonic flow apparatus

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 405 Heat and Mass Transfer (3 Units; Core; L = 30; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals of energy analysis and which will equip them with the requisite skills for the development of energy, thermal and renewable energy systems which is in agreement with BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce energy efficient and sustainable energy systems to address Africa’s energy challenges.

**Overview**

This course is designed to introduce a basic study of the phenomena of heat and mass transfer, to develop methodologies for solving a wide variety of practical engineering problems, and to provide useful information concerning the performance and design of particular systems and processes.

Students will learn the basics of heat transfer and how to apply these principles in the quantitative determination of heat transfer in thermal fluid systems and design of heat exchangers. Specifically, students will explore the three types of heat transfer: conduction, convection, and radiation.

**Objectives**

In this course students will learn to:

1. visualize and explore the three types of heat transfer: conduction, convection, and radiation.
2. explain and conceptualize how heat energy flows from place to place, always flowing from warmer to cooler substances until the temperature of both substances is the same (equilibrium).
3. discuss how various factors affect heat transfer, including temperature differentials, duration of contact, surface area, and type of material.
4. Use heat transfer enhancements techniques to optimize the heat transfer.
5. Design and analyse heat exchangers.

**Learning Outcomes**

At the end of the course the student is expected to be able to:

1. Identify and calculate the three different modes of heat transfer (conduction, convection and radiation) in a simple system.
2. Apply the concept of thermal resistance in the determination of heat transfer interactions in multi-layered systems in both rectangular and cylindrical co-ordinates.
3. Determine heat transfer rates by conduction in 2D steady systems and 1D transient systems
4. Differentiate between forced and natural convection and explain their mechanism
5. Apply empirical correlations to determine heat transfer coefficients in forced and natural convection in bounded and unbounded systems
6. Apply conduction and convection principle in the analysis of extended surfaces (heat transfer enhancement)
7. Apply heat transfer principles to the design of heat exchangers
8. Determine heat transfer rates by thermal radiation in black and grey bodies.

**Course Content**

**Conduction:** The general conduction equation. Steady one-dimensional conduction with and without generation. Steady quasi one-dimensional conduction. Steady two-dimensional conduction. Numerical solution of two-dimensional conduction equation. One-dimensional transient conduction. **Convection:** Forced convection-consideration of thermal boundary layer. Forced convection-Reynolds analogy and dimensional analysis. Natural convection. **Combined Conduction and Convection Heat Transfer:** Extended surfaces. The straight fin and spine. Limit of usefulness of the straight fin. Fin effectiveness and overall coefficients. Heat exchangers. Determination of heat transfer coefficients from heat exchanger tests. **Radiation:** The laws of black and grey body radiation. Absorption and reflection of radiant energy. Emission, radiosity and irradiation. Black and non Black bodies. Kirchoff law. Intensity of radiation. Radiation exchange between black surfaces. Grey-body radiation exchangers. Radiation coefficients. **Introduction to mass transfer:** Mass transfer processes

**Laboratory Experiments:**

1. Investigation of lagging efficiency and determination of thermal conductivity for various lagging materials

**Minimum Academic Standard**

Heat and Mass Transfer is as contained in the NUC CCMAS.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 406 Mechanics of Materials II (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable in the fundamentals and application of solid mechanics which is the science in which all design of machines is based on. It will equip them with the requisite skills for the analysis of the behavior of machines/structures subject to different loadings. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that have the requisite scientific background knowledge/skills to design/analyse machines and structures to solve problems.

**Overview**

In this course students will learn how to analyse the behaviour of structural and machine components subjected to different loading and support conditions in more than one dimension.

Students will also learn to analyse structural members such beams and columns subjected to loading beyond their Elastic limits (plastic deformation). They will also be able to analyse different structural elements using energy methods and understand the use of failure theories for different applications.

**Objectives**

In this course students will learn to:

1. discuss the behavior of different geometrical configurations of beams, columns and other structural elements subjected to different loadings.
2. use different techniques required to analyze stresses in various structural machine components.
3. analyses different energy methods used for structural analysis.
4. explain various theories of failure and their application in design.
5. Analyse stresses and deflection in Beams, columns and other structural elements

**Learning Outcomes**

Upon successful completion of this subject, the student should be able to:

* 1. Determine the stresses/or deflections in a curved, composite and unsymmetrical beam under different loading conditions
  2. Analyze the behavior of columns due to different loading conditions and develop formulas for the design of columns.
  3. Calculate stresses due to combine stresses in a structural machine component.
  4. Explain failure theories.
  5. Apply energy methods to the analysis of stresses and deflection in Beams, columns and other structural elements

**Course Content**

**Bending in Beams:** thick curved beams; the Winkler theory. Unsymmetrical bending. Composite beams. **Column and beam-column theory**; Euler columns and real columns. **Introduction to energy methods of structural analysis**: complementary energy and strain energy. Castigliano’s and Engesser’s theorems; the theorem of stationary complementary energy; potential energy; stationary potential energy; Rayleigh-Ritz method; Approximate methods of solution. **Theories of Elastic failure**.

**Minimum Academic Standard**

Mechanics of Materials II is as contained in the NUC CCMAS Advanced Mechanics of Materials course.

It requires laboratory with the following:

(i) Apparatus for tensile, compression and torsion tests.

(ii) Simple bending apparatus.

(iii) Unsymmetrical bending apparatus.

(iv) Impact tests apparatus.

(v) Elastic behaviour of thin- and thick-walled pressure vessels.

(vi) Creep and fatigue.

(vii) Theories of failure.

(viii) Helical springs.

(ix) Deflection of curved beams.

(x) Columns and struts.

(xi) Strain gauging, photo-elastic behaviour.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 407 Manufacturing Processes (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled the various manufacturing processes for the production of machine components or products. It will equip them with the skills to select the cost effective and efficient manufacturing process for the conversion of raw materials such as metals and non-metals to finished products. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce machines and their components from design meaning turn raw materials using manufacturing processes (non-machining) to finished products.

**Overview**

The aim of this course is to provide training on the broad spectrum of manufacturing processes and to introduce the learner to how each process works and its relative advantages and limitations.

Students will learn various manufacturing processes such as Casting, Forming, Forging, Joining and Welding Processes.

**Objectives**

In this course students will learn to:

1. Explain the various techniques of manufacturing machine parts using metals and plastics
2. Select appropriate processes for manufacturing industrial products/machine components;
3. Identify routings of the operations and equipment involved in changing raw materials into useable products;
4. Explain the mechanics involved in the various manufacturing processes.
5. Produce a product/machine component.

**Learning Outcomes**

Upon completion of this course the student will be able to:

1. Classify manufacturing process for metals and polymers
2. Explain the different technique such as Casting, Forming, Forging, Joining and Welding for manufacturing machine parts using metals and plastics
3. Select the appropriate manufacturing process for a particular applications, industrial product/machine component and materials (metals and polymers)
4. Identify routine of the operations and equipment involved in changing raw materials into useable products;
5. Explain the mechanics involved in the various manufacturing processes.
6. Fabricate a product/machine component by selecting and using the appropriate manufacturing process

**Course Content**

Classification of manufacturing processes for metal, and polymers.

- Casting and Moulding processes (Sand moulds, properties of sand. Cores and core sands, Design of Mould, centrifugal casting. Precision Casting, die casting, shell molding and investment casting); Forming processes (such as Rolling: Hot and Cold rolling, Defects in rolled metals; Drawing and deep drawing, Wire and tube drawing; Extruding and extrusion molding; Forging, Forging Defects in Forging). Joining methods (Gluing. Pressure welding. Cold welding and resistance welding processes. Fusion welding, electric arc and gas welding. Neutral, oxidizing and carbonizing flames. Welding with a chemical heat source. Thermit welding, Electron beam Welding; Powder Metallurgy; Project (in small groups) requires fabrication of a product using several different processes.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 408 Product Design (2 Units; Core; L = 15; P = 45)

**Senate Approved Relevance**

Training of high-quality graduates who are highly knowledgeable/skilled in the application of the design process to produce products that will address a particular need. It will equip them with the skills required to convert an idea into a finished product that is commercially acceptable or viable, through the application of the design process. This course will assist the BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce market ready products and solutions to engineering problems.

**Overview**

The course will train students on the use of creativity, design thinking, innovation and design process to bring new ideas, products and value to product users/customers.

Students will familiarize themselves with basic innovative methodologies and tools that can be used in product development through execution of a mini project.

**Objectives**

In this course students will learn to:

1. discuss the basic aspects of the product development process
2. Use the product design process to develop idea into product concept.
3. Apply creative processes and techniques in problem-solving and critical thinking in product design process
4. use safety, ergonomic, maintainability, environment, aesthetic, manufacture, assembly issues in product development.
5. Participate in real product design problem solving.

**Learning Outcomes**

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

1. Explain the basic aspects of the product development process
2. Apply the product design process to develop an idea into product concept.
3. Collect the required data from customers and establish technical specifications of a product
4. Generate different ideas to the solution of a product and systematically select the best idea.
5. Apply creative processes and techniques in problem-solving and critical thinking in conversion of an idea into a product that satisfy the consumer requirement
6. Apply safety, ergonomic, maintainability, environment, aesthetic, manufacture, assembly issues in the development of a product
7. Participate in real product design problem solving through the execution of mini project.

**Course Content**

*Introduction to product design and development; Product:* product definition, characteristics and specifications. Product life cycle*; Innovation and creativity in product design:* Innovation definition, types and application in product design, creativity definition, its applications and creativity tools in product design, idea generation and methods of generating ideas, skills required in product design; *Product design process*: Conceptual design and its processes, embodiment design and its processes and detail design processes in product design; *Design for X*: Design of product for safety, ergonomic, maintainability, environment, aesthetic, manufacture, assembly and others; *Mini project* on selected products involving innovative product design process.

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 502 Turbomachinery and Reciprocating Engines (3 Units; Core; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled and knowledgeable in the design, construction and maintenance of turbo machines and reciprocating fluid engines, in agreement with BUK’s mission to address African developmental challenges in producing highly skilled Mechanical Engineering graduates. Relevance is seen in Mechanical Engineers graduates from BUK being able to maintain, design, and develop turbo machines (turbines, compressors, blowers etc.) and reciprocating fluid engines (reciprocating pumps) necessary for the agricultural, power and industrial transformation of Nigeria and Africa.

**Overview**

Turbo machines and Reciprocating engines are integral parts of power, agricultural and industrial installations, and activities. This course is intended to introduce the basics of working principles of turbo machines and reciprocating fluid engines, in addition to their selection, design, analysis, performance evaluation and development.

Specifically, students will learn the principles of turbo machines and reciprocating fluid engines, and identity the different types of the machines. They will also learn design issues in their development, and how to select them for different applications. They will also learn to analyse and evaluate the performance of the machines.

**Objectives**

In this course students will learn to:

1. discuss the working principles of turbo machines and reciprocating fluid engines, and their different types.
2. explain the major components of turbo machines and reciprocating fluid engines
3. carry out design and analyses of the components of turbo machines and reciprocating fluid engines
4. analyse and evaluate the performance of turbo machines and reciprocating fluid engines
5. select turbo machines and reciprocating fluid engines for different applications

**Learning outcomes**

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

1. explain the working principles of a turbo machine, and identify the different types
2. use dimensional analysis and similarity (geometric, kinematic, dynamic) in analysis of performance characteristics (testing and efficiency of models and prototypes) of hydraulic machines
3. carry out energy transfer analyses of turbomachines using Euler’s equation
4. carry out power analysis, design and selection of pumps, hydraulic turbines, steam turbines, compressors, and gas turbines
5. explain cavitation in turbo machines, their causes, effects, stages and types, avoidance, etc.
6. explain the working principles of a reciprocating fluid engine (positive displacement machines) and identify the different types,
7. carry out power analysis and design of positive displacement machines

**Course contents**

**Introduction to Turbomachinery**: Working principles, types. **Dimensional Analysis**: Dimensions and Equations, The Buckingham P Theorem, Model Testing, Geometric Similarity, Kinematic Similarity, Dynamic Similarity, Prototype and Model Efficiency. **Energy Transfer in Turbomachinery**: The Euler Turbine Equation, Components of Energy Transfer. **Hydraulic Pumps: Centrifugal Pumps** (Slip Factor, Pump Losses, The Effect of Impeller Blade Shape on Performance, Volute or Scroll Collector, Vaneless Diffuser, Vaned Diffuser, Cavitation in Pumps, Suction Specific Speed), Axial Flow Pumps (Pumping System Design, Life Cycle Analysis, Changing Pump Speed, Multiple Pump Operation. **Hydraulic Turbines**: Pelton Wheel (Velocity Triangles, Losses and Efficiencies), Reaction Turbine (Turbine Losses, Turbine Characteristics), Axial Flow Turbine. **Centrifugal Compressors and Fans**: The Effect of Blade Shape on Performance, Velocity Diagrams, Slip Factor, Work Done, Diffuser, Compressibility Effects, Mach Number in the Diffuser, Characteristics, Stall, Surging, Choking. **Axial Flow Compressors and Fans**: Velocity Diagram, Degree of Reaction, Stage Loading, Lift-and-Drag Coefficients, Cascade Nomenclature and Terminology, 3-D Consideration, Multi-Stage Performance, Characteristics. **Steam Turbines**: Steam Nozzles, Nozzle Efficiency, The Reheat Factor, Metastable Equilibrium, Stage Design, Impulse Stage. **The Impulse Steam Turbine**: Pressure Compounding, Velocity Compounding. **Axial Flow Steam Turbines**: Degree of Reaction, Blade Height in Axial Flow Machines. **Axial Flow Gas Turbines**: Velocity Triangles and Work Output, Degree of Reaction, Blade-Loading Coefficient, Stator (Nozzle) and Rotor Losses, Free Vortex Design, Constant Nozzle Angle Design. **Radial Flow Turbines**: Velocity Diagrams, Thermodynamic Analysis, Spouting Velocity, Turbine Efficiency, Application of Specific Speed. **Cavitation**: Stages and Types of Cavitation, Effects and Importance of Cavitation, Cavitation Parameter for Dynamic Similarity, Cavitation Effects on Performance of Hydraulic Machines, Thoma’s Sigma and Cavitation Tests. **Reciprocating air compressors**: Indicator diagram

**Minimum Academic Standards**

As addition to what is contained in the CCMAS

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 503 Control System Engineering (3 Units; Core; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled and knowledgeable in the design, maintenance and, implementation of control systems that are integral parts of engineering machines and equipment, in agreement with BUK’s mission to address African developmental challenges in producing highly skilled Mechanical Engineering graduates. Relevance is seen in Mechanical Engineers graduates from BUK being able to maintain, design and, implement control systems for mechanical machines and installations, necessary for efficient and cost effective operations of machines necessary for industrial transformation of Nigeria and Africa

**Overview**

Control systems ensure that certain outputs of mechanisms respond according to changes in associated manipulated inputs. Virtually no machine is operated without an integral control system. This course is therefore designed to introduce the students to the fundamentals of control components and systems design and simulation.

Specifically, students will learn the basic control configurations and design principles. The students will learn the use of engineering systems mathematical models in the determination of control system characteristics (transient, steady state, stability) and predicting their performance. At each stage, simulations using MATLAB/Simulink will be employed to enhance learning

**Objectives**

In this course students will be taught to:

1. discuss control principles, its features, and different configurations
2. discuss the derivation of systems’ mathematical models and the analysis of control systems
3. use block diagrams and transfer functions to estimate the performance characteristics of control systems
4. identify major control system’s components and their transfer functions
5. simulate simple control systems using MATLAB/Simulink

**Learning outcomes**

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

1. explain the purpose of control systems and define basic control system features and configurations
2. explain systems representations in time and s-domains, obtain Transfer Function, classify and draw block diagrams, and obtain overall transfer functions from block diagrams
3. represent systems using block diagram, s-plane
4. derive mathematical models of electrical, mechanical, fluid, thermal and electromechanical systems and draw their block diagrams
5. understand the working principles of basic control systems components, and obtain their transfer functions
6. simulate mathematical models using computer programs like MATLAB/Simulink.
7. identify and understand the characteristics of basic control system components, and obtain their transfer functions
8. analyse and obtain quantitative measures of steady and transient responses of systems from transfer functions.
9. determine the stability of simple control systems from transfer function, and determine the range of a parameter required for stability
10. draw root locus and design cascade compensators and feedback compensators using root locus technique
11. implement control algorithms in microcontroller

**Course contents**

**Introductions**: definitions, applications, advantages, examples, control design process. **Features and Configurations**: open-loop/ closed-loop; manual/ automatic control systems, regulator/ servomechanism systems, linear/nonlinear systems, time variant/time invariant systems, transient/steady-state response, stability, design process. **System models and representations**: Laplace transforms, transfer function, systems classification and specifications, s-plane, block diagrams, block reduction techniques. Linear system analysis using MATLAB. Block diagram reduction using MATLAB. **Systems modelling**: Mechanical and Electrical systems, Electromechanical systems, Fluid and Thermal Systems, Geared systems. Simulating the models using computer programs like MATLAB/Simulink. **Control System Components**: Transducers and actuators. Mechanical, Electrical, Pneumatic, Hydraulic, Thermal control components. **Time response analyses of first and second order systems**: Standard test signals. Steady state analyses. Transient analyses and performance specifications - peak time, percentage overshoot, settling time. Transient system analysis with MATLAB. **Stability analysis**: stable, unstable, marginally stable systems. s-plane. Routh-Hurwitz criterion. **Root locus technique**: Sketching root locus. Plotting root loci with MATLAB. Control design using root locus method (cascade compensators, feedback compensators. Simple Class project of selected a control system, involving design and implementation using microcontroller

**Minimum Academic Standards**

As addition to what is contained in the CCMAS

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 504 Engineering Management (2 Units; Elective; L = 30)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled, confident and knowledgeable in business practices, organizational behavior and management skills to enable mechanical engineering students to succeed in engineering enterprise management roles. This is in agreement with BUK’s mission to address African developmental challenges in producing highly skilled Mechanical Engineering graduates.

**Overview**

The course is designed to expose students to the process of designing and maintaining an environment in which, individuals, working together in groups, efficiently accomplish organizational goals/objectives.

Specifically, students will learn the processes involve in production in industries, transport and materials handling, wage incentives, production planning and control, statistical quality control and financial management.

**Objectives**

In this course students will learn to:

1. evaluate key performance indicators in the industry such as productivity
2. describe wage incentive systems
3. understand production planning and control and to use tools such as CPM and PERT
4. apply statistical control tools for quality control in the industry.
5. apply financial management tools in decision making.

**Learning Outcomes:**

Upon conclusion of this course, the student should be able to:

1. Explain and evaluate key performance indicators in the industry such as productivity
2. Explain wage incentive systems
3. Explain production planning and control and to use tools such as CPM and PERT
4. Use statistical control tools for quality control in the industry
5. Use financial management tools for decision making

**Course content**

**Productivity:** Definition, factors affecting productivity in industry, how to increase productivity, measurement of productivity in industry. **Transport and materials handling**. Raw materials and equipment. Facility layout and location. Basic principles of work study – motion study and time study. **Wage Incentives:** Incentive plans, day rate plan, full participation plans, less than full-participation plan, the step plan. Personnel management, selection, recruitment and training, job evaluation and merit rating. **Production Planning and Control:** Production control in intermittent manufacturing, production control in continuous manufacturing, Planning and controlling in project management – Gantt chart, CPM and PERT. **Statistical Quality Control:** Kinds of control, acceptance sampling by attributes, operating characteristics curves, sampling, control charts for attribute, control charts for variables. **Financial management**, accounting methods, financial statements, cost planning and control, budget and budgetary control. Depreciation accounting and valuation of assets Cost Data for Decision: Fixed and variable costs, break-even analysis and construction of break-even chart. Capital costs and investment criteria: Capital costs, common criteria of comparing economic alternatives, present value criterion, average investment criterion, rate of return criterion, pay off periods.

**Minimum Academic Standards**

As addition to what is contained in the CCMAS Engineering (Project) Management

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 505 Refrigeration and Airconditioning (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled and knowledgeable in Refrigeration and air conditioning principles, and its application to the design, operation and maintenance of refrigerating and air-conditioning machines, in agreement with BUK’s mission to address African developmental challenges in producing highly skilled Mechanical Engineering graduates. Relevance is seen in Mechanical Engineers graduates from BUK who understand design and operational issues in refrigerating and air-conditioning, necessary for technological and socio-economic transformation of Nigeria and Africa.

**Overview**

Air conditioning and refrigeration systems are important features of our wellbeing and industrial development. Their design and operation require proper knowledge and training, hence the need for this course.

Specifically, students will learn about the performance characteristic of refrigerators, different refrigeration cycles, selection of refrigerants, estimate cooling loads and design refrigerators and air-conditioning system according to load demand.

**Objectives**

In this course students will be taught to:

1. Analyse the performance of refrigeration and air-conditioning systems
2. the use psychrometric chart as a tool to determine the properties of atmospheric air and to analyse air conditioning processes
3. determine of refrigeration and air-conditioning loads
4. select suitable refrigerant and compressor for particular application
5. Identify carious factors to determine human comfort and design an air-conditioning system different applications

**Learning outcomes**

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

1. determine the performance of refrigerators and heat pumps
2. perform the analysis of ideal and actual vapour compression refrigeration cycles
3. evaluate the performance of innovative vapour compression refrigeration systems
4. analyse gas cycle refrigeration systems and liquefaction of gases
5. determine the performance of absorption refrigeration system
6. use psychrometric chart as a tool to determine the properties of atmospheric air
7. determine refrigeration and air-conditioning load for refrigeration and air-conditioning systems
8. select suitable refrigerant and compressor for particular application
9. use the psychrometric chart to analyse air conditioning processes
10. explain the various factors that determine human comfort.
11. design an air-conditioning system for a particular application

**Course contents**

**Refrigeration Cycles:** The reversed Carnot cycle. The mechanical vapor compression cycle. The absorption refrigeration cycle. Air cycle refrigeration. Heat pumps. **Refrigeration Loads:** Convected heat. Product load. Infiltration and ventilation effects. Radiation effects. **Properties of Refrigerants:** Toxicity, inflammability, chemical activity, odour and oil solvent properties, Thermodynamic characteristics. **Refrigeration Compressors:** Reciprocating and rotary types. Hermetically sealed compressors. Lubrication. Fans. **Air-conditioning:** Review on gas and vapour mixtures, the properties of atmospheric air, dehumidification and humidification. Water injection. Steady injection. Mixing and adiabatic saturation with reheat. Human comfort and design of air-conditioning processes. Environmental influences on comfort. Environmental refreshness. **Air-conditioning Loads**: The metabolic rate. Bodily mechanisms of heat transfer. Estimating air-conditioning loads. Sizing of air-conditioning equipment.

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 506 Aerodynamics (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled and knowledgeable in the design, maintenance and implementation of aerodynamic systems, in agreement with BUK’s mission to address African developmental challenges in producing highly skilled Mechanical Engineering graduates. Relevance is seen in Mechanical Engineers graduates from BUK being able to design, construct and maintain aerodynamic systems (aerofoils, blades), used in aerodynamic machines (wind turbines, aeroplanes, gas turbines, etc.) necessary for the power, agricultural, and transportation transformation of Nigeria and Africa.

**Overview**

Aerofoils and their characteristics (shape, lift, drag, etc.) are very significant in the operation of aerodynamic systems, hence the need for this course. Students will be exposed to the engineering principles governing the design of aerofoils and experimental and analytical evaluation of their characteristics.

Specifically, students will learn aerofoil terminologies, design aerofoils, their applications, and determine their characteristics (lift, drag, etc.).

**Objectives**

In this course students will be taught to:

1. discuss aerofoil principles and terminologies
2. expalin thin aerofoil theory.
3. determination of characteristics of aerofoils (lift and drag forces)
4. determination of the performance of aerofoils analytically and experimentally
5. design and application of aerofoils (e.g. in wind turbines)

**Learning outcomes**

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

1. explain the aerofoil terminology
2. determine lift and drag forces of an infinitely long aerofoil
3. apply the thin aerofoil theory in the determination of the performance of an aerofoil
4. determine experimentally the performance characteristics of an aerofoil
5. design complete wind turbine blade

**Course contents**

General equations of flow in vectorial form. Aerofoil terminology. Flow past aerofoil with infinite length. Thin aerofoil theory. Practical aerofoils (shape, data and performance). Wakes, lift and Drag. Design of wind turbine blades.

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 507 Design and Analysis of Thermal Systems (3 Units; Elective; L = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled and knowledgeable in the design, maintenance and, analysis of thermal systems, in agreement with BUK’s mission to address African developmental challenges in producing highly skilled Mechanical Engineering graduates. Relevance is seen in Mechanical Engineers graduates from BUK contributing significantly to the pool of highly skilled manpower required to maintain and analyse the performance of Thermal systems (thermal power plants, heat exchangers, refrigeration and HVAC systems), for smooth industrial operation and growth of Nigeria and Africa.

**Overview**

Thermal systems feature prominently in power generating stations and many process industries. Their operations, maintenance and development demands mechanical engineers with requisite skills, hence the need for this course. Students will be exposed to the engineering principles governing the design and analysis of thermal systems.

Specifically, students will learn design and analyse thermal systems, model them, and apply software for system performance evaluation, diagnostics and optimization.

**Objectives**

In this course students will be taught to:

1. formulate models for the design and analysis of thermal systems
2. simulate thermal systems
3. evaluate the performance of thermal systems and components
4. optimize thermal energy system using software
5. carry out economic analysis of thermal systems

**Learning outcomes**

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

1. explain the methodology appropriate for the design of thermal systems
2. apply the basic principles of thermo-fluids engineering to the formulation of models for the design and analysis of thermal system components such as compressor, pump and etc.
3. apply thermal system design methodology to design a thermal system
4. design and analyse a complete thermal system consisting of various components
5. develop models for thermal systems and components
6. evaluate the performance of thermal systems and components through simulation
7. apply a software in the optimization of thermal energy system considering both performance and economics or cost

**Course contents**

**Introduction:** Thermal systems design methodology. Review of the basic principles of Thermodynamics, fluid mechanics and Heat transfer, Economic considerations. **Design and analysis of thermal system and components:** pump-pipe network, heat exchangers, compressors and turbines, power plants, refrigeration and HVAC systems. **Modelling and simulation of thermal systems and components:** Fitting component performance data (Curve fitting): Exact-fitting and least square methods. System simulation and evaluation (with simulation example). **System optimization:** Lagrange multipliers, search methods, geometric programming and application of software in optimization.

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**Mechanical Engineering**

# BUK-MEE 508 Introduction to CFD (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled and knowledgeable the design, fluid and thermal systems using Computational Fluid Dynamics (CFD) software, in agreement with BUK’s mission to address African developmental challenges in producing highly skilled Mechanical Engineering graduates. Relevance is seen in Mechanical Engineers graduates from BUK being able to design and analyse fluid systems using CFD software.

**Overview**

Computational Fluid Dynamic (CFD) uses numerical analysis and data structures to analyse and solve fluid flow problems. The method uses computes with high processing speeds, and CFD software. This provides a very veritable alternative to more expensive experimental analysis of such problems, hence the need for this course.

Specifically, students will learn how to define fluid flow geometry, discretize the volume, apply fluid flow equations and boundary conditions, and simulate the flow using computer with requisite software.

**Objectives**

In this course students will be taught to:

1. determine the steps involved in the numerical solution of the governing equations of fluid flow
2. select turbulence models appropriate for a problem
3. identify steps/principles involved in discretization, grid generation and selection of boundary conditions
4. use CFD software to the simulation and solution of simple fluid flow
5. use CFD software to the simulation and solution of heat transfer problem

**Learning outcomes**

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

1. derive the three (Mass balance, Newton’s law and Energy) fundamental principles governing the physical aspects of fluid flow
2. outline the steps involved in the numerical solution of the governing equations of fluid flow
3. select turbulence models appropriate for a problem
4. explain the steps/principles involved in discretization, grid generation and selection of boundary conditions
5. apply the CFD methodology to the solution of simple problems using finite difference
6. apply a CFD software to the solution of simple fluid flow and/or heat transfer problem

**Course contents**

The governing equations of fluid flow. Turbulence models. Discretization of the governing equations and Grid Generation. Boundary conditions. Basic Representative Examples using Finite difference. CFD Solution Methodology Application of a CFD software to solve simple fluid and heat transfer problem.

**Minimum Academic Standards**

It requires Finite Element Analysis Computational Tools such as:

(i) CATIA, NASTRAN, ABAQUS, IDEAS, MATLAB, ANSYS, etc.

(ii) CFD Software Packages such as: FLUENT, PHOENICS, ANSYS CFX, STAR-CD, etc.

(iii)Adequate Computational Facilities on which to install the software packages

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 509 Mechanical Building Services (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled, confident and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems through the application of mechanical building Services principles. This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply mechanical building Services principles to the construction/development of safer, more efficient and effective buildings and other related civil structures.

**Overview**

Mechanical Building Service is a vital tool used in the design, construction and maintenance of buildings and other related civil structures to enhance reliability and human safety. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on how to determine the air-conditioning loads in buildings and determine the various sizes of water supply/waste water pipes appropriate for a building.

This course is designed to expose students to various mechanical building services principles and also to equip the graduates with relevant skills for them to be able to produce appropriate designs for ventilation and water system for civil buildings.

**Objectives**

The objectives of the course are to:

1. Development of appropriate water supply and distribution network for buildings and other related civil structures
2. Estimation of cooling and heating loads in a building
3. Design and installation of ventilation systems in buildings
4. Identification of efficient, economic and sustainable methods of providing thermal comfort in civil structures
5. Design and installation of mechanical pumping system for the supply of water in buildings
6. Evaluation of the capacity of water storage medium for use in buildings and other related civil structures
7. Design and installation of appropriate transportation systems in buildings (lifts, escalators etc).

**Learning outcomes**

At the end of the course the student is expected to be able to:

1. Determine the various sizes of water supply/waste water pipes appropriate for a building
2. Estimate the water consumption based on occupancy and size appropriately the septic tank and soak-away
3. Determine the size of overhead tank and pump required for a particular application
4. Determine the air-conditioning loads in buildings considering all the necessary factors
5. Select appropriate air-conditioning system for a building
6. Design fire fighting systems appropriate for a building
7. Design/select appropriate vertical transportation systems based on the requirement of the application
8. Apply regulations and codes in the design of mechanical building services systems.

**Course contents**

Plumbing design: types and application of pipes. Pipe fittings. Design/Sizing of water supply and waste water systems. Codes and regulations. Airconditioning Design:Load calculations**:** Heat gain from solar and other sources. Factors influencing solar gains. Air conditioning load due to solar gain through glass, infiltration, heat gains through lighting, occupants, and other appliances. Sizing/selecting air-conditioning equipment. Fire Fighting: Fire fighting systems and design, equipment’s code and regulation. Transportation systems: sizing of lift, travellators and escalators.

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 510 Advanced Control Systems Engineering (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled and knowledgeable in the application of control principles to the design and operation of machines, in agreement with BUK’s mission to address African developmental challenges in producing highly skilled Mechanical Engineering graduates. Relevance is seen in Mechanical Engineers graduates from BUK being able to design, construct and implement control systems, and tune them for necessary for the power, agricultural, and transportation transformation of Nigeria and Africa.

**Overview**

Having introduced to the fundamental principles of control systems engineering, it is proper to demonstrate its application to the control of machines, hence the need for this course.

Here, students will learn about additional control system analysis using frequency response, design and feedback controllers, design compensators, and implement control algorithms in microcontrollers.

**Objectives**

In this course students will be taught to:

1. use of frequency response in the analysis of control systems performance
2. design feedback controllers and observers using state space
3. use software (e.g. MATLAB) to model digital systems, and to carry out design (transient, steady state, compensation)
4. apply control algorithms in microcontroller
5. analyze non-linearities in control systems, and how to linearize nonlinear systems

**Learning outcomes**

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

1. understand the principles behind frequency response, and to plot frequency response from transfer functions
2. analyse system transient and stability using frequency response
3. use frequency analyses to design cascade compensators
4. represent control systems in state space forms, and conversion from transfer function to state space
5. design feedback controllers and observers using state space
6. model digital systems, and to carry out design (transient, steady state, compensation)
7. understand non-linearities in control systems. Linearize nonlinear systems
8. implement control algorithms in microcontroller

**Course contents**

Frequency response analysis: definition, plots (polar plot, bode plots). Nyquist criterion, diagrams and stability. Steady-state, Transient and stability analyses using frequency repose plots. Systems design using frequency response method: gain adjustment, lag compensation, lead compensation, lag-lead compensation.Introduction to state space design. Systems representation in state space. Analysis of State equations. Transformation of systems models with MATLAB. Design using State Equation (pole placement, observer design. Discrete control systems: Z-domain**,** Z-transform properties, zero order holder, pole and zero plots in Z-plane, conversion from S-domain to Z-domain. Z-plane roots and stability, difference equation. Controller Design in Z-domain (transient, steady-state and stability design; compensation deign). PID design and Implementation in microcontroller. Introduction to non-linear systems: common types of non-linearity. Some effects of non-linearities on closed-loop control systems. Linearization of nonlinear systems

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 511 Ergonomics and Work Design (3 Units; Elective; L = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled, confident and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems through the application of ergonomics and work design principles. This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply ergonomic principles to the creation of safer, healthier and more efficient and effective activities in the workplace.

**Overview**

Ergonomics and work design principles are vital tools used in designing work, equipment and workplace to enhance human safety, performance and reliability. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on how to design a workplace according to good ergonomic principles as well as assessing ergonomic aspects of the working environment and work organisation.

This course is designed to expose students to various ergonomics and work design principles Also, to equip the graduates with relevant skills for them to develop appropriate control measures for ergonomic risk factors

**Objectives**

The objectives of the course are to:

1. Development of a workplace in accordance with the laid down ergonomic principles
2. Determination of appropriate activities in workplace with regards to safety and efficiency
3. Perform detailed ergonomic risk assessment in the working environment and work organization
4. Identification of the necessary control measures for ergonomic risk factors
5. Evaluation of human performance under heat, cold, illumination, vibration, noise, pollution, static and dynamic conditions.
6. Application of results from human factors data and analysis in work study and work design.

**Learning outcomes**

On completing this course successfully the student will be able to:

1. Apply ergonomic principles in the creation of safer, healthier, efficient and effective activities in the workplace.
2. Conduct ergonomic risk assessments
3. Develop appropriate control measures for ergonomic risk factors;
4. Describe work-related causes of musculo-skeletal disorders;
5. Design a workplace according to good ergonomic principles
6. Assess ergonomic aspects of the working environment and work organisation

**Course contents**

*Defining Human Factors* in a Production System; Characteristic features of man-machine system; Human performance and performance reliability. *Human Sensori-motor systems*, stimulus dimensions, human information processing, noise and theory of signal detection (TSD); Quantitative and qualitative visual displays; Human factors associated wish speech communication. *Continuous control systems*; Types of control functions tools and related control devices; Design of work place and work components; Applied anthropometry, activity analysis. *Human performance under* heat, cold, illumination, vibration, noise, pollution, static and dynamic conditions. *Introduction to biomechanics and bio-engineering* aspects of human motor activity; Performance of body members in making different types of movements; Energy expenditure in physical activities; Spatial movements and conceptual relationships of stimuli and responses. *Application of results from human factors data and analysis* in work study, work design, method study and work measurement techniques

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 512 Surface Treatments and Coatings (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

To produce high-quality graduates who are highly skilled, and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems. This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply the knowledge of surface treatments and coatings in the production/development and maintenance of mechanical engineering devices for the benefit of mankind, putting safety and reliability foremost.

**Overview**

S**urface Treatments and Coatings** are vital tools used in the design, construction and maintenance of mechanical devices to enhance reliability and human safety. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on corrosion and wear protection, and various functionalities obtainable by coatings and surface treatments.

This course is designed to expose students to fundamentals of industrial application of coatings and surface treatments including capability to propose appropriate coating solutions for various related problems.

**Objectives**

The objectives of the course are to:

1. Determination of coating deposition and surface modification methods
2. Enumerate the various properties of coatings and their related applications
3. Describe in details the industrial application of coatings and surface treatments
4. Apply the knowledge of coatings and surface treatment to enhance aesthetics
5. Development of corrosion and wear protection strategies

**Learning outcomes**

Having successfully completed this course, the student will be able to;

1. Describe the basic principles of coating deposition and surface modification methods
2. Explain the fundamental coating properties and their relationship
3. Design/develop corrosion and wear protection methods and various functionalities obtainable by coatings and surface treatments
4. Assess the industrial application of coatings and surface treatments including capability to propose appropriate coating solutions for various related problems
5. Evaluate the pros and cons of different approaches in surface engineering.

**Course contents**

*Introduction* to surface engineering of materials; *Surface Treatment*: Burnishing, diamond tools, wire brushing, polishing, buffing, harperizing, barrelling, vibratory finishing, electro-mechanical polishing, chemical polishing, electrolytic polishing, abrasive blast polishing (hydrodynamic) and blasting, metal shoot, anodizing; *Metal Cleaning*: Alkaline cleaning, emulsion cleaning, vapor degreasing, solvent cleaning, acid cleaning, pickling, descaling, derusting, dipping, etching; *Electro-Plating:* Principles of electro-plating, electro- plating standards, Cadmium zinc, copper, nickel chromium plating, including applications, preparation and maintenance of plating solutions, also equipment. quality control stripping of faulty deposits. Design of the process chart; *Metallic Coating*: (Hot dipping, metal spraying, cladding, vacuum coating); *Conversion coating*. Phosphating, chromating, anodizing, oxide blacking; *Organic coats*: Lacquers and varnishes. Paints; *Coating evaluation and testing*

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 513 Advanced Manufacturing Processes (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

To Train high-quality graduates who are highly skilled, confident and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems through the application of advanced manufacturing processes**.** This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply advanced manufacturing processes to the production of safer, reliable and more efficient mechanical engineering products/devices.

**Overview**

**Advanced manufacturing processes** are vital tools used in designing and fabrication of high-performance mechanical devices with excellent reliability. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on advanced manufacturing processes.

This course is designed to expose students to various principles and processing characteristics of ultra-precision machining, high-speed machining methods, and non-traditional machining to the production of components. Also, to equip the graduates with relevant skills for them to develop appropriate techniques for materials processing.

**Objectives**

The objectives of the course are to:

1. Identify various machining processes
2. apply advanced welding processes and techniques for the production of mechanical devices/machines.
3. Determine advanced casting processes suitable for processing materials.
4. Deign/develop new manufacturing processes for the production of high precision and reliable mechanical components
5. Evaluate working principle of other advance manufacturing processes.

**Learning outcomes**

Upon completion, students will be able to:

1. Describe the working principles and processing characteristics of ultra-precision machining, high-speed machining methods, and non-traditional machining to the production of components.
2. Determine the advanced casting processes suitable for processing materials.
3. Apply the advanced welding processes and techniques of joining materials for the production of mechanical devices/machines.
4. Explain the basic principles and operations of advanced metal forming processes
5. Evaluate the working principle of rapid prototyping technology, microwave processing of materials and other advance manufacturing processes.

**Course contents**

*Advanced Machining Processes:* Introduction Process principle, Material removal mechanism, Parametric analysis and applications of processes such as ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM), Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes; *Advanced Casting Processes*: Metal mould casting, Continuous casting, Squeeze casting, vacuum mould casting, Evaporative pattern casting, ceramic shell casting; *Advanced Welding Processes*: Details of electron beam welding (EBW), laser beam welding (LBW), ultrasonic welding (USW); *Advanced Metal Forming Processes:* High energy rate forming (HERF) process, Electro-magnetic forming, explosive forming, Electro-hydraulic forming, Stretch forming; *Other Advanced Processes:* Rapid Prototyping Technology, Microwave processing of materials etc.

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 514 Additive Manufacturing (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled, confident and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems through the application of Additive Manufacturing. This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply additive manufacturing to the production/development of safer, more efficient and effective products/mechanical devices for the benefit of mankind.

**Overview**

Additive Manufacturing is an essential tool used in the development and fabrication of various categories of machine components to enhance reliability and human safety. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on the processes used in additive manufacturing for a range of materials and applications.

This course is designed to expose students to the basic principles behind Additive Manufacturing (AM) and related technologies in the fabrication of machine components

**Objectives**

The objectives of the course are to:

1. identify processes used in additive manufacturing for a range of materials and applications
2. Distinguish between the various design techniques for Additive manufacturing
3. Describe the different forms of Additive manufacturing technologies
4. Apply the knowledge of Additive Manufacturing and related technologies in the production of highly complicated machine components
5. Evaluate the suitability and reliability of Additive manufacturing in the fabrication of machine components in Aerospace, Biomedical and Automotive industries.

**Learning outcomes**

Upon completion of this course the student will be able to:

1. Fully describe the basic principles behind Additive Manufacturing (AM) and related technologies.
2. Explain the processes used in additive manufacturing for a range of materials and applications
3. Describe different types of AM technologies.
4. Demonstrate understanding of design for AM
5. Apply the knowledge of Additive Manufacturing (AM) and related technologies in the fabrication of machine components

**Course contents**

Introduction to the Basic Principles of Additive Manufacturing (AM); Overview of Additive Manufacturing Processes and Technology; Applications of AM in Aerospace, Biomedical, Automotive, Bio-printing, Tissue & Organ Engineering, Architectural Engineering, Surgical simulation; AM Technology - Extrusion, Beam Deposition, Sheet Lamination, Direct-Write, Photo-polymerization, Sintering, Powder Bed Fusion, Jetting and latest new methods, such as HP’s Multi-Jet Fusion, CLIP and the latest methods for printing metal parts; Design for Additive Manufacturing, Related Technologies to AM: 3D Scanning, Injection Molding and Casting.

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 515 Theory of Elasticity (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled, confident and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems through the application of Theory of Elasticity. This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply theory of elasticity to the construction/development of safer and efficient mechanical components and machine parts.

**Overview**

Theory of Elasticity is an essential tool used in the design, construction and maintenance of mechanical devicesto enhance reliability and human safety. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on how to deal with elastic deformation problems for homogeneous isotropic materials and un-isotropic materials.

This course is designed to expose students to various basic concepts and analytical approach for the evaluation of the strength and deformation of mechanical components.

**Objectives**

The objectives of the course are to:

1. Explain the elastic and plastic deformation regions
2. apply analytical approach in the determination of the strength and deformation of mechanical components.
3. Assess the elastic deformation of homogeneous isotropic and un-isotropic materials
4. Evaluate the rate of deformation in thin rotating disc, thin plates and loaded springs
5. conduct tortional deformation of long shafts of various dimensions
6. estimate thermal stresses in mechanical components

**Learning outcomes**

Upon successful completion of this course the student will be able to:

1. Differentiate between elastic and plastic deformation principles
2. Evaluate the stress-strain relation in the elastic region.
3. Analyse thin rotating disc and bending of thin plates.
4. Determine the torsional deformation of uniform bars
5. Conduct thermal stress analysis of mechanical components
6. Determine the shear stresses in beams
7. Evaluate the deformation in loaded springs

**Course contents**

**Introduction:** Introduction to general elasticity and plasticity.

Uniaxial tensile test with Preference to elasticity problems; Nominal and true stress. Engineering and logarithmic strains. Equilibrium equations. Strain- displacement relations. Compatibility equations. Stress-Strain relations in the elastic region, Material's stress strain relations. Boundary conditions. Airy’s stress functions. Stress concentration. Analysis of thin rotating discs. Bending of thin plates. Membrane theory of thin shells. Torsion of uniform bars, exact theory based on Saint-Venant stress function and Brandtl's membrane analogy. Approximate theory for thin walled tubular sections. The Bredt-Batho equation. Distribution of shear stresses in beams. Thermal stresses, contact problems and deformation of springs.

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 516 Materials Characterization (3 Units; Elective; L = 45)

**Senate-approved relevance**

Train high-quality graduates who are highly skilled, confident and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems through the application of materials characterization**.** This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply knowledge of materials characterizationto the design and development of various materials for the fabrication of safer, more efficient and reliable engineering components.

**Overview**

Materials Characterization is a vital tool used in the design, production and maintenance of various engineering components to enhance reliability and human safety. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on the principles and uses of various material characterisation methods.

This course is designed to expose students to the fundamentals and applications of MechanicalCharacterizationsand also to equip the graduates with relevant skills for them to be able to produce appropriate materials (both simple and composite) for various engineering components.

**Objectives**

The objectives of the course are to:

1. identify various material characterization methods.
2. describe the Micro-structural/morphological characterization method.
3. explain the Mechanical characterization methods
4. Discuss the thermal characterization methods
5. Apply the knowledge and skills of materials characterizations to produce appropriate materials for various engineering components.

**Learning outcomes**

The student should be able to:

* + 1. Describe the various Mechanical characterization methods
    2. Read and interpret the micrographs of various micro-structural/morphological tools.
    3. Plot and discuss the various mechanical characterisation tools.
    4. Plot and discuss the various thermal characterisation tools.
    5. Evaluate the suitable mechanical characterization strategy for particular applications
    6. Apply the knowledge and skills of materials characterizations to develop composites materials appropriate for various engineering components.
    7. Conduct materials characterization tests

**Course contents**

**Fundamentals and Applications:** Principles and uses of various material characterisation methods; **Micro-structural/morphological Characterization:** Fourier-transform infrared spectroscopy (FT-IR), Raman spectroscopy, Particle size distribution, Energy dispersive X-ray fluorescence spectrometer (ED-XRF), Scanning electron microscopy/Energy dispersive X-ray spectroscopy (SEM/EDX), X-ray diffraction (XRD), Transmission Electron microscopy (TEM), High-Resolution Transmission Microscopy (HRTEM)/Field-Emission Transmission Electron Microscopy (FETEM). **Mechanical Characterizations:** Tensile, compressive, hardness, torsional, impact, creep and fatigue testing. **Thermal Characterizations:** Thermo-gravimetric analysis/Differential Thermo-gravimetric (TGA/DTG), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Thermal diffusivity, Specific heat capacity and Thermal conductivity.

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 517 Mechanics of Metal Forming (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled, confident and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems through the application of Mechanics of Metal Forming**.** This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply mechanics of metal forming to the design and production of safer, reliable and efficient engineering components.

**Overview**

Mechanics of Metal Forming is an essential tool used in the design, construction and maintenance of engineering components to enhance performance, reliability and human safety. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on the various metal forming techniques.

This course is designed to expose students to various metal forming processes and also to equip the graduates with relevant skills for them to be develop appropriate procedures for the production of high quality engineering products in an economical and sustainable way.

**Objectives**

The objectives of the course are to:

1. Identify the various metal forming methods
2. Analyse the various methods of metal forming
3. describe the mechanism behind sheet metal forming technique
4. Assess the advantages and disadvantages of each metal forming process
5. Evaluate suitable metal forming technique for the production of particular engineering component

**Learning outcomes**

It expected that, at the end of this course, the student should be able to;

1. Distinguish between the various metal forming methods
2. Determination of the forces involved in the various metal forming methods
3. Evaluation of the rate of deformation associated with the various metal forming techniques
4. Conduct analyses of the pros and cons of each metal forming process in the production of engineering components
5. Differentiate between cold working and hot working techniques.
6. Apply the knowledge of mechanics of metal forming in the design and fabrication of high-quality engineering products.

**Course contents**

Mechanics of the following metal forming processes: Rolling of Metals, Forging, Extrusion, Drawing, Sheet metal forming

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 518 Fracture Mechanics (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled, confident and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems through the application of Fracture Mechanics**.** This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply the knowledge of fracture mechanics in the design of crack resistant mechanical parts for the production of safer and efficient mechanical devices.

**Overview**

Fracture mechanics is a vital tool used to analyse the stable and unstable crack growth in a mechanical component to enhance performance, reliability and human safety. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on how to determine the factors affecting fatigue cracks and their implications on mechanical members.

This course is designed to expose students to various crack detection techniques on a mechanical component and also, to equip the graduates with relevant skills for them to design/develop crack resistant mechanical parts.

**Objectives**

The objectives of the course are to:

1. Identification of the various crack detection techniques in a mechanical component
2. Description of the basic characteristics of cracked bodies
3. Conduction of fatigue crack growth analysis in a mechanical component
4. Application of the knowledge of fracture mechanics in the design of crack resistant mechanical parts
5. Determination of the factors affecting fatigue cracks in mechanical members,

**Learning outcomes**

Upon successful completion of this course the student will be able to:

1. Fully explain the fracture mechanics concept
2. Describe the basic characteristics of cracked bodies
3. Evaluate the stress and displacement fields in cracked bodies
4. Analyse the stable and unstable crack growth in a mechanical component
5. Discuss the various crack detection techniques in a mechanical component
6. Conduct fatigue crack growth analysis in a mechanical component

**Course contents**

**Fracture Mechanics Concept:** Fracture mechanics and strength of solids, stress and displacement fields in cracked bodies, The Griffith - or wan-Irwin concept, Stable and unstable crack growth

**Fatigue Crack growth:** Stress intensity factor range, Empirical expressions for crack growth rate, factors affecting fatigue crack growth rate, Fracture Mechanics design approach:

**Crack detection techniques:** Initial flaw sizes**,** Design procedure in the presence of cracks**,** Examples of designing with cracks**,** Stress Intensity Factor (SIF)**,** Basic characteristics of cracked Bodies

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 519 Tribology (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Training of high-quality graduates who are highly skilled, confident and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems through the application of tribology principles. This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply tribology principles to the design and development of safer, more efficient and effective mechanical devices.

**Overview**

Tribology is a vital tool used in the design, construction and maintenance of friction related mechanical devices to enhance reliability and human safety. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on how to Apply the theory of friction to determine friction between metallic, non-metallic, dry and lubricated surfaces.

This course is designed to expose students to the various principles of friction to design, analyse and produce mechanical devices.

**Objectives**

The objectives of the course are to:

1. Describe the theory behind self-acting and pressurized bearings
2. Application of the theory of friction to determine friction between metallic, non-metallic, dry and lubricated surfaces
3. Determination of the friction in gearing systems
4. Use the principles of friction to design and analyse mechanical devices
5. Selection of appropriate type of bearing suitable for an application

**Learning outcomes**

The student should be able to:

1. Apply the theories of friction to determine friction between metallic, non-metallic, dry and lubricated surfaces
2. Explain the theory behind self-acting and pressurized bearings
3. Determine friction in gearing systems
4. Use the principles of friction to design and analyse brakes and dynamometers
5. Select appropriate type of bearing suitable for an application
6. Design Journal, thrust, sliding and rolling contact bearings

**Course contents**

Theories of friction between metallic, non-metallic, dry and lubricated surfaces. Testing and properties of materials, solid and liquid lubricants.

Theory of self- acting and pressurised bearing including Reynolds equation and solutions, dynamic loading, temperature, and pressure effects on viscosity. Elasto-hydrodynamic lubrication, gears, rolling contact bearings and Hydrostatic bearings, Brakes and Dynamometers

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**Mechanical Engineering**

# BUK-MEE 520 Vehicle Dynamics (3 Units; Elective; L = 30; P = 45)

**Senate-approved relevance**

Train high-quality graduates who are highly skilled, confident and knowledgeable in the design, analysis, manufacture, operation and maintenance of mechanical systems through the application of Vehicle Dynamics**.** This is in agreement with BUK’s mission to address both national and African developmental challenges. Relevance is attached to seeing mechanical engineering graduates from BUK being able to apply Vehicle Dynamics principles to the design, construction/development of safer, reliable and efficient motor vehicle parts and performance analysis.

**Overview**

Vehicle Dynamics is a vital tool used in the design, construction, maintenance and performance analysis of motor vehicle parts to enhance reliability and human safety. This highlights the importance of preparing students in mechanical engineering with the knowledge and skills on how to analyse motor vehicle power train, brakes, wheels, tyres, steering and suspension systems.

This course is designed to expose students to the design, production and maintenance of various parts of the automobile and also to equip the graduates with relevant skills to conduct performance analyses of these components to enhance safety and reliability.

**Objectives**

The objectives of the course are to:

1. Conduct motor vehicle performance analysis
2. Determine the appropriate gear ratios for effective power transmission
3. Evaluate the basic requirements for directional stability, brake force distribution, types of brakes shoe factors and materials.
4. Assess motor vehicle tyres for load bearing and speed rating
5. Develop steering gear requirements

**Learning outcomes**

At the end of the course, the student should be able to;

1. Describe motor vehicle engine characteristics, engine speed and fuel consumption pattern
2. Explain the basic principles behind the operation of motor vehicle power train system
3. Design clutch and gearing system for effective power transmission
4. Determine the appropriate brake force distribution and brake shoe materials
5. Apply the knowledge of wheel and vehicle handling to obtain the tyre cornering force characteristics, plane motion and stability of motor vehicles.

**Course contents**

**Vehicle performance:** Engine characteristics, resistance to motion, maximum speed and acceleration performance, gradability, fuel consumption. **Power train:** Clutch, gear box, determination of gear ratios, prop shaft, Unusual and constant velocity, joint, differential and rear axles. **Brakes:** Basic requirements, directional stability, weight transfer, brake, force distribution, types of brakes shoe factors and materials. **Tyres:** Tyres and construction material. Manufacture of tyres, tread patterns, tyre designation, speed rating, ply rating, aspect ratio, rules of tyre mixing. **Wheel and vehicle handling:** Basic dimension and designation. Tyre cornering force characteristics, plane motion and stability of vehicles. **Steering and suspension systems:** Basic types, geometrically correct steering, Ackerman linkage, turning circle radius, steering gear requirements. Basic functions and components, geometry of dependent and independent suspension.

**Minimum Academic Standards**

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B.ENG. Mechanical Engineering**

# BUK-MEE 521 Introduction to FEMs (3 Units; Elective; L = 45)

**Senate Approved Relevance**

The philosophy is to produce mechanical engineering graduates with high academic standards and adequate practical skills for self-employment as well as been of immediate value to industry and the community in general.

**Overview**

The course will introduce students to Finite Element Analysis (FEM) techniques to solve problems related to solid mechanics, dynamics and heat transfer. In particular, students will have hands-on experience in using finite element analysis software such as ANSYS, MSC Nastran and others to solve realistic mechanical engineering problems.

Students will be required to undertake independent design projects.

**Objectives**

The objectives of the course are to:

1. Describe the basic concepts and techniques of finite element analysis
2. Describe the application of finite element analysis techniques in solving problems related to solid mechanics.
3. Describe the application of finite element analysis techniques in solving problems related to vehicle dynamics to heat
4. Describe the application of finite element analysis techniques in solving problems related transfer in automotive systems.

**Learning outcomes**

At the end of the course, the student should be able to;

1. Explain the basic concepts and techniques of finite element analysis
2. Apply finite element analysis techniques in solving problems related to solid mechanics.
3. Apply finite element analysis techniques in solving problems related to vehicle dynamics
4. Apply finite element analysis techniques in solving problems related to heat transfer in automotive systems.

**Course Contents**

Introduction: Engineering design analysis-meaning and purpose. Basic concepts of FEM. Advantages and limitations of FEM. Test for convergence. Element choice. Commercial finite element packages- organization-advantages and limitations. Raleigh Ritz's, Galerkin and finite difference methods- Governing equation and convergence criteria of finite element method. Solid mechanics: Formulation of element stiffness matrices-1D bar and beam elements. Plane stress, Plane strain and axisymmetric problems, constant and linear strain triangular elements, stiffness matrix, axisymmetric load vector, quadrilateral elements, Isoparametric elements. Treatment of boundary condition. Numerical Integration. Dynamics Analysis: Equations of motion for dynamic problems. Consistent and lumped mass matrices. Formulation of element mass matrices. Free vibration problem formulation. Torsion problems. Heat Transfer and Fluid Flow Analysis: Basic equations of heat transfer and fluid flow problems. Finite element formulation. One dimensional heat transfer and fluid flow problems. Derivation of element matrices for two dimensional problems.

**Minimum Academic Standards**