**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

## **30% ADDITION TO CCMAS**

## **SUMMARY**

**100 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| BUK-TAE 103 | General Physics III | 2 | C | 30 |  |
| BUK-TAE 104 | General Physics IV | 2 | C | 30 |  |
|  | **TOTAL** | **4** |  |  |  |

**200 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| BUK-TAE 201 | Applied Electricity II | 2 | C | 15 | 45 |
| BUK-GET 202 | Machine Drawing | 2 | C | 15 | 45 |
| BUK-GET 207 | Applied Mechanics | 3 | C | 15 | 45 |
|  | **TOTAL** | **7** |  |  |  |

**300 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| BUK-TAE 301 | Automotive Electricals and Electronics | 2 | C | 15 | 45 |
| BUK-TAE 302 | Engineering Economics | 2 | C | 30 | - |
| BUK-TAE 303 | Automotive Fuels & Lubricants | 2 | C | 15 | 45 |
| BUK-TAE 304 | Theory of Machines I | 2 | C | 15 | 45 |
| BUK-TAE 305 | Theory of Machines II | 2 | C | 15 | 45 |
| BUK-TAE 306 | Manufacturing Processes | 2 | C | 15 | 45 |
| BUK-TAE 307 | Automotive Internal Combustion Engines | 3 | C | 15 | 45 |
| BUK-TAE 308 | Applied Thermodynamics | 2 | C | 15 | 45 |
| BUK-TAE 309 | Applied Fluid Mechanics | 2 | C | 15 | 45 |
| BUK-TAE 310 | Mechanics of Materials | 2 | C | 15 | 45 |
|  | **TOTAL** | **21** |  |  |  |

**400 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| BUK-TAE 401 | Combustion, Pollution and Control | 2 | C | 15 | 45 |
| BUK-TAE 402 | Design of Automotive Engines | 3 | C | 30 | 45 |
| BUK-TAE 403 | Automotive Systems Design | 2 | C | 15 | 45 |
| BUK-TAE 404 | Automobile Service and Maintenance | 2 | C | 15 | 45 |
| BUK-TAE 405 | Automobile Driving and Care | 2 | C | 15 | 45 |
| BUK-TAE 406 | Power Trains and Transmission | 2 | C | 15 | 45 |
| BUK-TAE 407 | Finite Element Analysis of Structures | 2 | C | 15 | 45 |
| BUK-TAE 408 | Applied Aerodynamics | 2 | C | 15 | 45 |
| BUK-TAE 409 | Dynamics and Control | 2 | C | 15 | 45 |
|  | **TOTAL** | **19** |  |  |  |

**500 Level**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| BUK-TAE 501 | Vehicle Air Conditioning | 2 | C | 15 | 45 |
| BUK-TAE 502 | Alternative Vehicle Propulsion Systems | 2 | C | 15 | 45 |
| BUK-TAE 503 | Noise, Vibration, and Harshness | 2 | C | 15 | 45 |
| BUK-TAE 504 | Computer Aided Design/Computer Aided Manufacture (CAD/CAM) | 3 | C | 30 | 45 |
| BUK-TAE 505 | Vehicle Body and Chassis Engineering | 2 | C | 15 | 45 |
| BUK-TAE 506 | Automotive On-board Diagnostics | 2 | C | 15 | 45 |
| BUK-TAE 507 | Advances in Automotive Technology | 2 | C | 30 | - |
| BUK-TAE 508 | Facilities Design & Ergonomics | 2 | C | 15 | 45 |
| BUK-TAE 509 | Automobile Transport and Fleet Management | 2 | C | 30 | - |
| BUK-TAE 510 | Heat and Mass Transfer | 3 | C | 30 | 45 |
|  | **Sub-Total** | **22** |  |  |  |
|  | Optional 1 | 2 | O | 30 |  |
|  | Optional 2 | 2 | O | 30 |  |
|  | **TOTAL** | **26** |  |  |  |

**Optional Courses**\*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Units** | **Status** | **LH** | **PH** |
| BUK-TAE 521 | Advanced Manufacturing Technology | 2 | O | 30 | - |
| BUK-TAE 522 | Robotics and Robot Applications | 2 | O | 30 | - |
| BUK-TAE 523 | Special Purpose Vehicles | 2 | O | 30 | - |
| BUK-TAE 524 | Computational Fluid Dynamics | 2 | O | 30 | - |
| BUK-TAE 525 | Vehicle Body Work & Painting | 2 | O | 15 | 15 |

\*Every student is expected to register for any two optional courses.

**Total Credits Added per Level**

|  |  |
| --- | --- |
| **Level** | **Credits/Units** |
| 100 | 4 |
| 200 | 7 |
| 300 | 21 |
| 400 | 19 |
| 500 | 22 + 4 Optional |
| **Total** | **73 + 4 Optional** |

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

# **BUK-TAE 103 General Physics III (Electricity & Magnetism)** (2 Units; C; LH= 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:

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

Physics Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 104:** **General Physics IV (Vibrations, Waves and Optics)** (2 Units; C; LH = 30) = 15, PH = 15

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1). The course will provide early broad–based training in general science required for advanced study in automotive engineering. This will contribute to achieving the mission of Bayero University; “training of high-quality graduates” and contributing to building a workforce capable of creating jobs and wealth.

**Overview**

The course is designed to equip students with both theoretical and practical skills in vibration, waves and optics required for training automotive engineering undergraduate students. The knowledge and skills acquired in this course will lay the foundation for subsequent higher level courses in engineering and are also critical in any other wave-related courses.

The course will focus on the production, propagation and manipulation of waves including light. Topics include geometric optics, forced damped oscillators, elasticity and distortion, the wave equation, wave speed and propagation, polarisation, wave packets, interference and diffraction, 3-D waves, plane and circular waves, and physical optics. The course will be taught through lectures explaining the basic principles and theory of the discipline. Exercises will be focused on practical topics presented in lectures.

**Course Objectives**

1. Describe principles of Simple Harmonic Motion (SHM)
2. Describe the behaviour of vibrating systems and wave energy;
3. Describe the propagation and properties of waves in sound and light;
4. Derive and discuss wave equations; and
5. Describe the concepts of geometrical optics and principles of optical instruments.

**Learning Outcomes**

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

1. Explain the principles of Simple Harmonic Motion (SHM)
2. Explain and quantitatively analyse the behaviour of vibrating systems and wave energy;
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 Contents**

Simple harmonic motion (SHM). Energy in a vibrating system. Damped SHM. Resonance and transients. Coupled SHM. Q values and power response curves. 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 wave equation. 2-D and 3-D wave equations. Wave energy and power. Phase and group velocities. Echo and beats. The Doppler-effect. Propagation of sound in gases, solids and liquids and their properties. Optics: Nature and propagation of light. Reflection and refraction. Internal reflection. Scattering of light. Reflection and refraction at plane and spherical surfaces. Thin lenses and optical instruments. Wave nature of light. Dispersion. Huygens’s principle (interference and diffraction)

**Minimum Academic Standard**

Physics Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-GET 201: Applied Electricity II** (2 Units; C; LH = 30; PH=15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1). This will contribute to achieving the mission of Bayero University; “training of high-quality graduates” and contribute to building workforce capable of creating jobs and wealth.

**Course Overview**

The course is designed to equip students with both theoretical and practical skills in applied electricity II required to produce Automotive Engineering graduates. The course will provide early broad–based training in general science required for advanced study in automotive engineering. Provides non-electrical engineering students a basic understanding of the principles and analysis of electric circuits, transformers and motors while exposing them to electrical engineering applications.

**Objectives**

In this course students will learn:

1. To design and troubleshoot electronics and electrical circuits including electric power systems
2. The principle of operation and the effect of pulsating, rotating magnetic fields on the working of AC machines
3. The staring, speed control methods and equivalent circuit diagram of poly phase and single phase machines.

**Learning Outcomes**

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**

Electric Power/Machine Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-GET 202: Machine Drawing** (2 Units; C; LH = 30; PH=30)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The aim of the course is to strengthen the capacity of students for a career in Automotive Engineering. The course is designed to equip students with both theoretical and practical skills in machine drawing using real automotive components. The course will focus on using innovative hands-on approaches using relevant software. Students will be required to undertake practical drawing exercises using automotive components.

**Course Objectives**

The objectives of the course are to:

1. Describe the principles and procedure for developing working drawings,
2. Conduct exercises on detain drawings of automotive components,
3. Describe the procedure for developing working drawings using CAD Software,
4. Describe the features of AUTOCAD, CATIA or SOLID WORKS as tools for machine drawing,
5. Conduct exercises on the drawing of automotive components using AUTOCAD, CATIA or SOLID WORKS,
6. Explain the procedure for preparing technical documentation.

**Learning Outcomes**

After completing this course, students should be able to:

1. Recognize the principles of machine drawing and its documentation,
2. Explain the principles of machine drawing using a CAD Software,
3. Demonstrate competencies in working drawings of automotive components.
4. Distinguish between the procedures for using AUTOCAD, CATIA or SOLID WORKS in machine drawing,
5. Evaluate the compliance of working drawings to standards,
6. Develop working drawings and accompanying technical documentation for automotive components.

**Course Content**

Working Drawing: Sectioning, Dimensioning. Dimensional and Geometric Tolerancing. Limits and Fits, BS 308 Conventions. Detail and Assembly Drawing of Fasteners and Locking Devices. Automotive Units. Welding Drawing and Specification. Drawing Documentation. Introduction to Computer-Aided Drafting (CAD). CAD Software: AUTOCAD, CATIA, or SOLID WORKS. Use of CAD software to prepare working and assembly drawings of automotive components.

**Minimum Academic Standard**

1. Drawing and Design Studio
2. CAD Software (AUTOCAD, CATIA, SOLID WORKS etc.)

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

# **BUK-GET 207 Applied Mechanics** (3 Units; C; LH = 30; PH= 15)

**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:

1. the basic concepts and system of forces.
2. understand the relationship of physical process, kinetics and kinematics.
3. to develop skills to use the basic principles of mechanics in engineering application
4. to analyze the mechanism of friction in different systems such wedges, belt drives and screws.
5. the concept of virtual work, degrees of freedom and potential energy.
6. How to use Newton’s second law and other laws of kinetics to solve problems.
7. How 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**

Dynamics and Control Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 301: Automotive Electricals and Electronics** (2 Units; C; LH = 30; PH= 15)

-, (2 Units; Elective; LH = 30)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1). This will contribute to achieving the mission of Bayero University; “training of high-quality graduates” in automotive engineering and contribute to building workforce capable of creating jobs and wealth.

**Overview**

Automotive electronics such as autonomous driving, all-electric cars and in-car infotainment are some of the new trends in the automotive industry. The course will introduce students to the principles and applications of electrical and electronic components used in vehicles. Emphasis is placed on recommendations outlined in the National Automotive Industry Development Plan (NAIDP).

**Course Objectives**

The objectives of this course are to:

1. Describe Electrical & Electronic technologies in an automobile
2. Diagnose and repair electrical and electronic systems in automotive vehicles; and
3. Use necessary electrical equipment to aid in diagnosis of automotive vehicles.
4. Describe Automotive Networking, Bus Systems, LIN Bus, MOST Bus
5. Explain Architecture of Electronic Systems & Diagnosis Interfaces
6. Describe Control Units and Automotive Sensors, Actuators, Hybrid Drives, Vehicle Electrical Systems, Starter Batteries and Battery

**Learning Outcomes**

After completing this course, students should be able to:

1. Recognize the electrical and electronic components found on a vehicle;
2. Explain the construction and principles of operation of automotive electrical and electronic components.
3. Identify and check wiring circuits and the electrical components in the vehicle
4. Perform basic electrical testing, battery testing and charging operations in a vehicle
5. Construct basic electronic circuits and testing.

**Course Contents**

Storage Battery**:** Principle of lead acid cells. Plates and their characteristics, containers and separators. Electrolyte and their preparation. Effect of temperature on electrolyte, its specific gravity, capacity and efficiency. Defects and remedies of batteries.

Charging and Lighting System**:** Characteristics of D.C. Generators and Alternators. Control cutout, Electrical, Electro-mechanical and electronic regulators. Regulations for charging. Wiring requirements, insulated and earth return system. Details of head light and side light, LED lighting system, head light dazzling and preventive methods.

Starter Motor & Drives**:** Battery motor starting system. Condition at starting, behaviour of starter during starting. Consideration affecting size of motor, types of drives, starting circuit.

Ignition Systems and Engine Management Systems*:*Ignition fundamentals. Types of solid state ignition systems. Components, construction and operating parameters. High energy ignition distributors. Electronic spark timing, Ignition Advance, Types DIS, MBT and control. Combined ignition and fuel management systems. Exhaust emission control, Digital control techniques – Dwell angle calculation, Ignition timing calculation and Injection duration calculation.

Chassis Electrical Systems.Antilock Brake System (ABS). Active suspension, traction control, electronic control of automatic transmission. Central locking; Air bags and seat belt tensioners. Microprocessor and Microcomputer controlled devices in automobiles such as instrument cluster.

Electronic Accessories*:*Warning and alarm instruments. Brake actuation warning system, traficators, flash system, oil pressure warning system, engine overheat warning system, air pressure warning system, speed warning system, door lock indicators, neutral gear indicator, horn design, permanent magnet horn, air & music horns. Wind shield wiper, window washer, instrument wiring system and electromagnetic interference suppression, wiring circuits for instruments, electronic instruments, and dash board illumination.

**Minimum Academic Standard**

* 1. Automobile systems and vehicle dynamics laboratory
  2. Automobile workshop

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 302: Engineering Economics**  (2 Units; C; LH = 30); Elective; LH =

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1). The course will provide broad–based training and equipped the students with skills to assess the costs and benefits of engineering investments, such as product and technology development programs and capital purchases. This will contribute to achieving the mission of Bayero University; “training of high-quality graduates” and contribute to building workforce capable of creating jobs and wealth.

**Course Overview**

Engineering Economy is the process of making rational and intelligent decisions associated with the allocation of scarce resources in circumstances in which alternatives can be enumerated. This course will introduce students to basics of engineering economics, which is the application of economics and decision theory to the evaluation of engineering alternatives in planning, developing, constructing, and managing engineering projects. The course will include segments of the engineering economic analysis covered in the professional engineering such as the application of different economic analysis methods utilized in evaluating the viability of a project and its alternatives, concepts of replacement decisions, capital-budgeting decisions, and project risk and uncertainty. Students will be exposed to specific issues of economic analysis of the private sector versus the public sector.

**Course Objectives**

The objectives of the course are to:

1. Discuss the basic concepts of engineering economy,
2. Describe the techniques for making economic decisions using present worth, annual worth, future worth, and capitalized cost,
3. Discuss discounted cash flow and rate of return comparisons,
4. Describe the procedure for replacement analysis, breakdown analysis, and benefit-cost analysis,
5. Analyze practical examples to judge attractiveness of an investment.

**Learning Outcomes**

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

1. Recall the basic concepts of engineering economy,
2. Solve examples involving making economic decisions using present worth, annual worth, future worth, and capitalized cost,
3. Explain discounted cash flow and rate of return comparisons,
4. Solve examples using replacement analysis, breakdown analysis, and benefit-cost analysis techniques,
5. Solve practical problems to judge the attractiveness of a proposed investment.

**Course Contents**

The nature and scope of economics. Basic concepts of engineering economy. Interest formulae, discounted cash flow, present worth, equivalent annual growth and rate of return comparisons. Replacement analysis. Breakdown analysis. Benefit-cost analysis. Minimum acceptable rate of return. Judging attractiveness of proposed investment.

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 303: Automotive Fuels and Lubricants** ( (2 Units; C; LH = 30; PH= 15); Elective; LH = 2 Units; Elective; LH = 30)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1). The course will train students towards achieving the mission of Bayero University of “training of high-quality graduates” in automotive engineering and contribute to building workforce capable of creating jobs and wealth in Nigeria.

**Course Overview**

This course has been designed to educate students on the properties of fuels and lubricants required for the proper operation of the automotive systems. Student will gain the essential understanding and knowledge about the automotive engine fuels and lubricants. Students will learn about the oil composition and how automotive engine lubricants are formulated. They will learn the basic engine oil functions, basic engine oil properties, such as viscosity, flash point. Why SAE viscosity is important when choosing the right lubricant, how API or ACEA performance level helps us choose the right oil for the right application. By the end of the course he should be able to choose the right fuel and lubricant for appropriate application.

Fuels are the energy sources for any vehicle and lubricants are used to reduce energy losses due to friction. Both are available in very wide range but only some of them have found their application in vehicle because of their some desirable properties. Their use not only affects the engine performance and vehicle life but also affect the environment. Due to different chemical composition different fuels behave differently during combustion process. To justify the selection of proper fuel and lubricants for particular vehicle and particular assembly students of automobile engineering must have knowledge of fuels and lubricants.

**Course Objectives**

The objectives of the course are

1. To describe the processes involved in the manufacture of fuels and lubricants,
2. To describe the properties and testing of petroleum-based fuels,
3. To describe the peculiarities of Natural Gas, CNG, LPG, Hydrogen, and Biogas and their utilization as automotive fuels,
4. To describe the peculiarities of biofuels and their utilization as fuels for automotive engines,
5. Explain the theory of lubrication and its application in the automotive engine,
6. Describe the peculiarities and characteristics of lubricants and engine fluids used in automobiles

**Learning Outcomes**

After completing this course, students should be able to:

1. Recall the processes involved in the manufacture of fuels and lubricants,
2. Recall the properties and testing of petroleum-based fuels,
3. Explain the peculiarities of Natural Gas, CNG, LPG, Hydrogen, and Biogas and their utilization as automotive fuels,
4. Outline the peculiarities of biofuels and their utilization as fuels for automotive engines,
5. Recall the theory of lubrication and its application in the automotive engine,
6. Explain the peculiarities and characteristics of lubricants and engine fluids used in automobile.

**Course Contents**

**Manufacture of Fuels and Lubricants***:*Structure of petroleum; refining process; fuels; thermal cracking; catalytic cracking; polymerization; alkylation; isomerisation; blending; products of refining process; Manufacture of lubricating oil base stocks; manufacture of finished automotive lubricants. **Properties and Testing of Petroleum-based Fuels***:* Thermo-chemistry of fuels; properties and testing of fuels; relative density; calorific value; distillation; vapour pressure; flash point; spontaneous ignition temperature; viscosity; pour point; flammability; ignitability; diesel index; API gravity; aniline point; cetane and octane numbers; Additive: mechanism; requirements of an additive; petrol fuel additives and diesel fuel additives; specifications of fuels. **Natural Gas**; CNG, LPG; Hydrogen and Biogas**:** Availability; properties; modification required to use in engines; engine performance and emission characteristics using alternate fuels; Hydrogen; storage and handling; performance and safety aspects. **Biofuels**:Economic, environmental and political issues; Biofuel policies. Vegetable Oils:Various vegetable oils for engines; sun flower; soyabean; peanut; rape side; palm oil; jatropha and neem; Esterification; performance in engines; performance and emission characteristics; bio-diesel and its characteristics. Stability and Technical issues. Alcohols: Feedstocks, Production, and utilization. Economic, environmental and other technical issues. **Theory of Lubrication**: Engine friction: introduction; total engine friction; effect of engine variables on friction; hydrodynamic lubrication; elasto-hydrodynamic lubrication; boundary lubrication; bearing lubrication; functions of the lubrication system; **Lubricants:** Specific requirements for automotive lubricants; oxidation deterioration and degradation of lubricants; additives and additive mechanism; synthetic lubricants; classification of lubricating oils; properties of lubricating oils; tests on lubricants; Grease; classification; properties; test used in grease**. Engine Fluids**:Requirement and properties of coolants, brake, clutch, and transmission fluids.

**Minimum Academic Standard**

Fluids and lubricants laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 304: Theory of Machines I**  (2 Units; C; LH = 30; PH= 15);

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1). The course will train students towards achieving the mission of Bayero University of “training of high-quality graduates” in automotive engineering and contribute to building workforce capable of creating jobs and wealth in Nigeria.

**Course Overview**

This course will introduce students to the theory of mechanics of mechanisms and machines. The theory of machines offers teaching from the basics of machine engineering such as motion, to more advanced studies of free and forced vibration, friction in bearings, geared systems and governors. The design of a modern machine is often very complex. In the design of a new engine, for example, the automotive engineer must deal with many interrelated questions. What is the relationship between the motion of the piston and the motion of the crankshaft? What are the sliding velocities and the loads at the lubricated surfaces, and what lubricants are available for this purpose? This falls into the science of mechanics as it relates to the design of mechanisms and machines.

It will be helpful to the students to understand the mechanisms from operational point of view, concepts, principles, procedure, kinematics and dynamics involved in different machine elements and mechanisms like lever, gear, cam, follower, belt, flywheel, brake, dynamometer, clutch, etc. Detail knowledge of above-mentioned aspect with deep insight to the practical applications will assist in developing professional confidence in students to become successful Engineer. Machines and mechanisms have always been used as tools to improve both the lives and lifestyles of mankind. Human beings started using them by converting natural resources into various forms and shapes of ancient man-made tools. As the engineering world progresses the upcoming engineers have to be educated and trained for these latest technological developments and also have to be imparted with more skills in the form of research and development. Theory of Machines and Mechanisms course is one of the essential courses of Mechanical and automotive Engineering undergraduate curriculum.

**Course Objectives**

The objectives of the course are:

1. Introduce the basic laws of statics and dynamics and their applications in problem solving
2. Explain scalar and vector approaches for representing forces and moments acting on particles and rigid bodies and their equilibrium
3. Introduce basic knowledge on kinematic and dynamic design of machinery.
4. Develop skills for velocity, acceleration, and force analyses for linkages, cams, gears and other mechanisms

**Learning Outcomes**

After completing this course, students should be able to:

1. Recognize the concepts and principles of mechanisms and machines,
2. Analyze and synthesize mechanisms commonly found in automobile.
3. Analyse and resolve forces, moments and solve problems using various principles and laws of Mechanics
4. Apply the concept of equilibrium to rigid bodies and solve problems
5. Draw velocity, acceleration, and force diagrams for linkages, cams, gears and other mechanisms

**Course Contents**

Kinematics of mechanisms. Loci, graphical analysis, instantaneous centres, images. Flexible shaft couplings, virtual work, energy and speed fluctuations in machines. The flywheel and mechanical governors. Acceleration of geared system, equilibrium of machines, brakes and dynamometers. Acceleration and braking of vehicles.

Gear tooth geometry, involumetry. Spiral gearing. Cams, displacement diagrams, layout, equivalent mechanisms. Force analysis of mechanisms: Four-bar linkage, slider-crank, and crank-connecting rod mechanisms. Fluctuation of kinetic energy and inertial effects.

**Minimum Academic Standard**

Dynamics and Control laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 305: Theory of Machines II**  (2 Units; C; LH = 30; PH= 15);

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

This course will acquaint students with tools required to synthesize / analyze various mechanisms used in different mechanical devices. Kinematics and theory of machines is a fundamental course for mechanical engineering. It is intended to introduce essential elements of machines and their functionality. This course is essential for synthesis and kinematics analysis of machine elements like linkages, cams, belt, rope, brakes, clutch and gear.

Machines and mechanisms have always been used as tools to improve both the lives and lifestyles of mankind. Human beings started using them by converting natural resources into various forms and shapes of ancient man-made tools. As the engineering world progresses the upcoming engineers have to be educated and trained for these latest technological developments and also have to be imparted with more skills in the form of research and development. Theory of Machines and Mechanisms course is one of the essential courses of Mechanical and automotive Engineering undergraduate curriculum. The course will train students towards achieving the mission of Bayero University of “training of high-quality graduates” in automotive engineering and contribute to building workforce capable of creating jobs and wealth in Nigeria.

**Course Objectives**:

1. Describe various types of Mechanisms and their synthesis.
2. Analyse the position, velocity and acceleration of mechanisms and to familiarize higher pairs like cams and principles of cams design.
3. Explain the working principles of different type reciprocating and rotating parts/components.
4. Describe the relative motion analysis and design of gears, gear trains.

**Learning Outcomes**

After completing this course, students should be able to:

1. Recognize the principles used in the analysis and synthesis of mechanisms;
2. Explain the construction and operation of different mechanisms used in machines;
3. Use the principles to analyze/synthesize mechanisms found in automobile.
4. Analyze the planar mechanisms for position, velocity and acceleration and design cams and followers for specified motion profiles.
5. Evaluate gear tooth geometry and select appropriate gears for the required applications

**Course Contents**

Introduction to Mechanisms and Machines. Kinematic links, pairs, and chains. Kinematic inversions. Four bar planer mechanisms. Mobility and range of movement. Miscellaneous mechanisms (straight line, steering, pantograph).

Synthesis of Mechanisms: Type, number and dimensional synthesis. Function generation, Path generation/position generation. Two and three position synthesis of four bar/slider crank mechanisms by graphical and analytical methods. Freudenstein’s equation, precision positions, structural error, and Chebychev’s spacing. Transmission angle.

Cams: Classification of cams and followers. Disc cam nomenclature. Construction of displacement/velocity/acceleration diagrams for different types of follower motions. Synthesis of cam profile by graphical and analytical approaches. Cams with specified contours/ tangent and circular arc cams.

Gears: Fundamental law of gearing. Involute spur gears. Characteristics of involute action. Interference and undercutting. Center distance variation. Involutometry. Nomenclature of Helical/Bevel/Worm gears.

Gear Trains: Synthesis of simple, compound and reverted gear trains. Analysis of epicyclic gear trains.

Balancing of Rotating Components:Static/dynamic balancing. Balancing of rotating masses. Two plane balancing; graphical and analytical methods. Balancing of rotors. Field balancing. Balancing machines.

Balancing of Reciprocating Parts: Balancing of single cylinder engine. Balancing of multi-cylinder - inline/radial/V-type engines. Firing order.

**Minimum Academic Standard**

Dynamics and Control laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 306: Manufacturing Processes**  (2 Units; C; LH = 30; PH= 15); Elective; LH = (2 Units; Elective; LH = 30)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will introduce students to concepts of manufacturing processes that are used in industry to manufacture products that are widely used in daily life. It will introduce students to theory and operation of manufacturing including manufacturing processes and equipment overview, manufacturing design, production process and flow, materials and machine operations.

The course will provide students with the opportunity to acquire detailed understanding of manufacturing processes used in industry. The course also includes quality assurance of manufactured parts by inspection and testing. It will also highlight major design guidelines for each manufacturing process to be successful.

**Course Objectives**

The course objectives are to:

1. Describe the principles and concepts of manufacturing processes used in the industry.
2. Describe the principles and techniques used in casting, shaping, forming, property enhancing, joining and assembly processes.
3. Discuss the different types of traditional and non-traditional material removal processes,
4. Describe the principles and concepts of powder metallurgy,
5. Describe polymers, their composites and production methods
6. Describe the various methods of joining mechanical components,
7. Describe the concepts of additive manufacturing and 3D printing,
8. Describe the principles and techniques of quality assurance.

**Learning Outcomes**

After completing this course, students should be able to:

* + 1. Outline the principles and concepts of manufacturing processes used in the industry.
    2. Explain the principles and techniques of casting, shaping, forming, property enhancing, joining and assembly processes.
    3. Differentiate between traditional and non-traditional material removal processes,
    4. Explain the principles and concepts of powder metallurgy,
    5. Explain polymer and polymer composite production processes
    6. Explain the methods of joining mechanical components
    7. Explain the principles of additive manufacturing and 3D printing
    8. Explain the principles and techniques of quality assurance.

**Course Contents**

Introduction to Manufacturing Processes: Materials in manufacturing. Manufacturing Processes. Production Systems. Fundamentals of Metal Casting: Heating and Pouring. Solidification and Cooling. Metal Casting Processes: Expendable and Permanent Mold Casting Processes. Casting Quality. Product Design Considerations. Bulk deformation (forging, rolling, drawing, extrusion). Sheet metal forming. Traditional and Nontraditional material removal processes (ECM, EDM, laser, electron beam, water jet). Powder Metallurgy. Polymer and polymer composites processing. Joining (welding, adhesives, rivets). Additive manufacturing. 3D printing. Quality assurance principles and techniques.

**Minimum Academic Standard**

1. Materials Laboratory
2. Precision Laboratory
3. Metrology Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

# **BUK-TAE 307: Automotive Internal Combustion Engines** (2 Units; C; LH = 30; PH = 15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

This course introduces students to spark ignition (SI) and compression ignition (CI) engines, their construction and operation, fuel systems, cooling systems, and lubrication systems. The course will also introduce students to the principles of combustion and emission generation in SI and CI engines.It looks at the various emerging power technologies in the automotive industry andthe current and alternative fuels.

**Course Objectives**

The objectives of the course are:

1. To describe the construction and operation of SI and CI engines
2. To discuss the construction and operation of fuel systems of SI and CI engines
3. To describe the construction and operation of cooling system of SI and CI engines
4. To discuss the construction and operation of lubrication system of SI and CI engines
5. To describe principles of combustion and emission generation in SI and CI engines

**Learning Outcomes**

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

1. Explain the construction and operation of SI and CI engines
2. Explain the construction and operation of fuel systems of SI and CI engines
3. Explain the construction and operation of cooling system of SI and CI engines
4. Explain the construction and operation of lubrication system of SI and CI engines
5. Explain the principles of combustion and emission generation in SI and CI engines

**Course Contents**

**Engine Construction and Operation:** Constructional details of 4-stroke petrol and diesel engines. Working principles of Otto cycle, Diesel cycle and actual indicator diagrams. Two stroke engine construction and operation. Theoretical scavenging methods. Scavenging pumps. Comparison of four stroke and two-stroke engine operation. Firing order and its significance.

**Fuel System of SI Engines:** Carburettor working principle. Requirements of an automotive carburettors; Starting, idling, acceleration and normal circuits of carburettors, compensation, Maximum power devices, constant choke and constant vacuum carburetors. Fuel feed systems, Mechanical and electrical pumps. Petrol injection.

**Fuel Injection System:** Requirements, Air and fuel injection, function of components, Jerk and distributor type Pumps. Pressure waves, Injection lag, Unit injector, Mechanical and Pneumatic governors. Fuel injector-types of injection nozzle, Spray characteristics, injection timing, pump calibration.

**Cooling System of SI and CI Engines:** Need for cooling system. Types of cooling system, Liquid cooled system, Thermo-syphon system, and Pressure cooling system.

**Lubrication system:** Mist lubrication system, Wet sump and dry sump lubrication. Properties of lubricants. Properties of coolants.

**Combustion Chambers:** Importance of air motion-swirl, squish and turbulence-swirl ratio. Fuel air mixing –stages of combustion, delay period, factors affecting delay period. Knock in CI engines-comparison of knock in SI and CI engines. Direct and indirect injection. Combustion

Chambers-Air cell chamber, combustion chamber design objectives. Different types of combustion chamber.

**Supercharging and Turbocharging:** Necessity and limitation, Charge cooling, Types of supercharging and turbocharging, relative merits, matching of turbocharger.

**Diesel Engine Testing and Performance:** Automotive and stationary diesel engine testing and related standards. Engine power and efficiencies. Performance characteristics. Variables affecting engine performance. Methods to improve engine performance. Heat balance. Performance maps.

**Minimum Academic Standard**

Engine Testing Laboratory

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

# **BUK-TAE 308 Applied Thermodynamics** (2 Units; C; LH = 30; PH = 15)

**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 etc., 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 etc. which forms the basis for air-conditioning design.

**Objectives**

In this course students will learn:

1. The techniques required for the analysis and performance evaluation of various Rankine Power Cycles
2. The techniques required for the analysis and performance evaluation of various Gas Power Cycles
3. The techniques required for the analysis and performance of combined power cycles.
4. How to determine properties and perform energy analysis of non-reacting gas mixtures.
5. How to 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 etc.)
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 Contents**

**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.

**Minimum Academic Standard**

Thermo-fluids Laboratory

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

# **BUK-TAE 309 Applied Fluid Mechanics** (2 Units; C; LH = 30; PH = 15)

**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.

**Objectives**

In this course students will learn to do the following:

1. Describe various kinematic elements of flow using the velocity field and understand the concepts of stream function and velocity potential.
2. Describe and 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 Contents**

**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.

**Minimum Academic Standard**

1. Thermo-fluids Laboratory
2. Dynamics and Control Laboratory

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

# **BUK-TAE 310 Mechanics of Materials** (2 Units; C; LH = 30; PH = 15)

**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:

1. To enable students to 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. To use Lame’s theorem to design and analyze pressurized cylinders.
5. Analyse structural members beyond their elastic 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 Contents**

**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**

* 1. Dynamics and Control Laboratory
  2. Materials Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 401: Combustion, Emission and Control (**2 Units, C, LH = 30; PH= 15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will introduce students to the principles of combustion, emissions formation and control. Students will understand the origin of anthropogenic greenhouse gas (GHG) emissions attributed to automotive engines and the possible means of controlling them.

**Course Objectives**

The objectives of the course are:

1. To describe the concept and principles of combustion of hydrocarbon fuels,
2. To describe the principles of emission formation mechanism in SI and CI engines,
3. To compare the principles of emission control in automotive SI and CI engines,
4. To demonstrate the effect of fuel properties on emission and pollution,
5. To conduct practical sessions of emission measurements using different emission meters.

**Learning Outcomes**

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

1. To recall the principles and concepts of combustion of hydrocarbon fuels,
2. To explain the principles of emission formation mechanisms in SI and CI engines,
3. To differentiate between emissions control mechanism in automotive SI and CI engines,
4. To illustrate the effect of fuel composition on emissions and air pollution,
5. To design experiments to measure emissions using different emission meters.

**Course contents**

Combustion of Fuels: Chemical composition and molecular structure of hydrocarbon fuels. Fuel spray characteristics, droplet size, depth of penetration and atomization. Combustion stoichiometry of hydrocarbon fuels. Chemical energy and heat of reaction calculations. Chemical equilibrium and adiabatic flame temperature calculation. Theory of combustion in SI and CI engines.

S.I. Engine Emissions and Control: Emission formation in SI Engines. Carbon monoxide & Carbon dioxide, unburned hydrocarbon, NOx, and smoke. Catalytic converters, charcoal canister. Positive crank case ventilation system. Secondary air injection. Laser assisted combustion.

Emission from C.I. engine and its control. Formation of white, blue, and black smokes, NOx, soot, sulphur, as well as particulate and intermediate compounds. Effect of operating variables on emission formation. Fumigation, split injection, catalytic coating, EGR, HCCI, and particulate traps.

Influence of fuel properties on emission and effect on air pollution:Effect of petrol, Diesel fuel, Alternative fuels, and lubricants on emissions. Effect of air pollution on human health, plants, and animals.

Test procedures and emission Measurements: Constant volume sampling. Sampling procedures. Seven mode and thirteen mode cycles for emission sampling. Emission analysers: NDIR, FID, Chemiluminescent smoke meters, Dilution tunnel, SHED Test, Sound level meters.

**Minimum Academic Standards**

1. Engine Laboratory
2. Emission meters

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 402: Design of Automotive Engines** (3 Units, C, LH = 30, PH = 45**)**

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will expose the students to the processes involved in the design of automotive engines. Particular attention will be given to the differences between SI and Ci engines.

**Course Objectives**

The objectives of the course are:

1. To describe the concepts and principles of engine operating cycle,
2. To describe the theoretical and design principles of engine cylinders and liners,
3. To describe the theoretical and design principles of the piston, piston rings and piston pin,
4. To describe the theoretical and design principles of connecting rod and crank shaft,
5. Describe the theoretical and design principles of the gas exchange mechanism,
6. Explain the procedure for the design of engine cooling, fuel, and lubrication systems,
7. Distinguish the differences in the design of SI and CI engines.

**Learning Outcomes**

After completing this course, students should be able to:

1. Recall the principles and concepts engine operating cycle,
2. Explain the procedure for designing engine cylinders and liners,
3. Explain the processes and procedure for designing engine piston, piston rings and piston pin,
4. Explain the theoretical and design principles of connecting rod and crank shaft,
5. Explain the theoretical and design principles of the gas exchange mechanism,
6. Demonstrate competencies in the design of engine cooling, fuel, and lubrication systems,
7. Modify the design of a given SI or CI engine.

**Course Contents**

Operating Cycle: Analysis of working fluid; Heat balance; Engine sizing. Overall efficiency. Indicated and effective performance parameters. Cylinders and liners: Design, cylinder wear and corrosion, details of water jacket, dry and wet liners, Cylinder head design. Piston, piston rings, piston pin: Design, stress analysis, methods of manufacture. Compensation of thermal expansion in pistons. Heat treatment, piston ring selection. Limits of fit for pins. Connecting rod:Design, effects of whipping, bearing materials, lubrication. Crank shaft: Design, firing order, balancing and torsional vibration analysis, vibration dampers, bearings. Engine Systems: Design of fuel, cooling, and lubrication systems. Flywheel:Design. Camshaft: Drives of cams, materials, types (only descriptive). Valve and valve mechanism: Design, types of valves, operating mechanisms, valve springs, guides, push rods, rocker arms, tappets, and valve timing diagrams. Crank Case: Design of crank case, oil sumps and cooling features.

Manifolds: Construction and design of inlet and exhaust manifolds.

**Minimum Academic Standards**

Design Studio, CAD Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 403: Automotive Systems Design** (2 Units, E, LH = 30, PH= 45**)**

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will familiarize students with the principles of design of braking systems, transmission systems and suspension systems. Students will also be introduced to the concepts and procedure for design optimization used in automobile systems. Students will be required to undertake independent design projects.

**Course Objectives**

The objectives of the course are to:

1. Describe the principles of design of automotive braking systems
2. Describe the procedure for the design of transmission systems
3. Describe the procedure for the design of suspension systems
4. Describe the procedure for the design of flywheels and bearings,
5. Describe the concepts and procedure for design optimization used in automobile systems
6. Discuss the procedure for conducting independent design projects.

**Learning Outcomes**

After completing the course, students should be able to:

1. Explain the principles of design of automotive braking systems
2. Explain the procedure for the design of transmission systems
3. Explain the procedure for the design of suspension systems
4. Explain the procedure for the design of flywheels and bearings,
5. Explain the concepts and procedure for design optimization used in automobile systems
6. Execute independent design projects.

**Course Contents**

**Design of Clutches:** Design requirements of friction clutches, selection criterion, torque transmission capacity, lining materials, Design of single plate clutch, multi-plate clutch and centrifugal clutch.

**Design of Gearbox:** Selection of gear ratios & final drive ratio, Design of gears, shafts, splines and housing, selection of bearings.

**Final Drive Design:** Design of final drive & differential gearing, Selection of wheels and tyres,

**Brake Systems:** Design of Hydraulic Braking System, Internal Expanding Shoe Brake and Disc Brake.

**Design of Axles & Propeller Shafts**: Design of front & rear axles, Design of Propeller shafts for bending, torsion & rigidity, Design of universal joints and slip joints.

**Design of Suspension System**: General design considerations of suspension system, Design of leaf springs for automobile suspension system, Design considerations of Belleville springs, Elastomeric springs, Air (Pneumatic) springs.

**Optimization**: Introduction to design optimization of mechanical elements, adequate & optimum design, methods of optimization, Johnson’s method of optimum design-Simple problems in optimum design like axially loaded members, shaft subjected to torsional and bending moments and other machine elements.

**Individual/Group Project:**

1. Design & working details and assembly drawing of automotive clutch system.

Shall comprise of: Functional design of clutch, Design of clutch shaft, hub and flange, Design of damper springs, Design of sectors, rivets etc., Design of pressure plate assembly, Design for linkage mechanism, Details and assembly drawing,

2. Design & working details and assembly drawing of automotive gear box.

Shall comprise of: Calculation of gear ratios, Determination of number of teeth on gear pair, Determination of gear reductions, Design of gear pairs, Design of shafts, Selection of bearings, Details and assembly drawing,

3. Design of automotive brake system.

**Minimum Academic Standards**

Design Studio, CAD Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 404: Automobile Service and Maintenance** (2 Units, C, LH = 15, PH = 30**)**

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The aim of the course is to produce Automotive Engineering graduates who can work in automobile industry, service stations, private transport companies, defense services or self-employed by setting up automobile garages and maintenance workshops. The course is designed to equip students with both theoretical and practical skills in automobile service and maintenance.

The course will provide students with the opportunity to acquire hands-on skills on automobile maintenance. Students will be exposed to theoretical and practical fault diagnosis and repair in real time. The course will be delivered in collaboration with local Automobile Maintenance Workshops in Kano.

**Senate-approved relevance**

The course will contribute to achieving the mission of Bayero University; “training of high-quality graduates” and contribute to building workforce capable of creating jobs for themselves and others.

**Course Objectives**

The objectives of the course are to:

1. describe maintenance workshop practices and safety tools,
2. explain the principles, concepts and categories of automobile maintenance,
3. describe automotive engine and engine systems maintenance,
4. conduct practical exercises on engine and engine systems diagnoses,
5. conduct practical exercises on automotive chassis diagnoses,
6. describe operational principles and maintenance of vehicle steering, brake, suspension, transmission, and hydraulic systems,
7. describe operational principles and maintenance of vehicle body system,
8. describe operational principles and maintenance of vehicle electrical and air conditioning systems,
9. conduct practical exercises on diagnosis and repair of vehicle steering, brake, suspension, transmission, and hydraulic systems,
10. conduct practical exercises on diagnosis and repair of vehicle electrical and hydraulic systems.

**Learning Outcomes**

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

1. identify maintenance workshop practices and safety tools,
2. explain the principles, concepts and categories of automobile maintenance,
3. explain automotive engine and engine systems maintenance,
4. diagnose and repair engine and engine systems,
5. diagnose and service automotive chassis,
6. describe operational principles and maintenance of vehicle steering, brake, suspension, transmission, and hydraulic systems,
7. recall operational principles and maintenance of vehicle body system,
8. describe operational principles and maintenance of vehicle electrical and air conditioning systems,
9. diagnose and service vehicle steering, brake, suspension, transmission, and hydraulic systems,
10. diagnose and service vehicle electrical and hydraulic systems.

**Course contents**

Maintenance, Workshop Practices, Safety and Tools. Automotive service procedures. Safety of Personnel, machines, and equipment. Types of maintenance services. Engine and Engine Subsystem Maintenance. Service of cooling, lubricating, fuel, intake and exhaust, and electrical systems. Transmission and Driveline Maintenance. Service of front and rear axles, bearings and differential assemblies. Steering, Brake, Suspension, and Wheel Maintenance. Inspection, Maintenance and Service of leaf spring, shock absorbers. Dismantling and assembly procedures. Wheel alignment and balancing. Inspection, maintenance and service of steering linkage, steering column, Rack and pinion steering, worm type steering, power steering systems. Fault diagnosis using scan tools. Auto Electrical and Air Conditioning Maintenance. Maintenance of air conditioning parts. Leak detection AC Charging- Fault diagnosis. Vehicle body repair.

**Minimum Academic Standards**

1. Automotive Engine Laboratory
2. Automotive Scan Tools
3. Maintenance Workshop

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 405: Automobile Driving & Care** (2 Unit, C, LH = 15, PH = 15**)**

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

This course will provide students with the opportunity of becoming qualified and certified automobile drivers. Students will have hands-on experience in driving different categories of automobiles leading to certification.

The course will be delivered in collaboration with the Vehicle Inspection Office (VIO) of the Kano State Ministry of Works as well as with the Federal Road Safety Corps of Nigeria (FRCN), Kano Command.

**Course Objectives**

The objectives of the course are to:

1. Describe vehicle driving signs,
2. Describe the rules and regulations for vehicle driving,
3. Describe the procedure for issuing driving license in Nigeria,
4. Demonstrate the procedure for traffic management in Nigerian cities,
5. Describe the principles of GPS-based vehicle navigation system,
6. Conduct hands-on practical sessions on vehicle driving and licensing.

**Learning Outcomes**

After completing this course, students will be able to:

1. Recall automobile driving signs,
2. Explain the rules and regulations for vehicle driving,
3. Recognize the justification and procedure for the issuance of driving license in Nigeria,
4. Appraise the traffic management systems used in Nigerian cities,
5. Explain the principles of operation of GPS-based vehicle navigation system,
6. Use the skills acquired to get a Driving License from the Federal Road Safety Coup.

**Course Contents**

Driving Code: Symbols, signs, marks. Driving License (DL): Necessity, age limit to obtain DL, and learner’s DL. Permanent DL: grant, restrictions, renewal, and. Endorsement, disqualification, suspension, fees, documents, and educational qualifications required for driving trucks, buses, oil tankers, and missile carriers. Driving schools: requirements, effectiveness of different DLs, Maintenance of state registers of DLs. Traffic Management and Administration: Vehicle Inspection Officers. Federal Road Safety Coups of Nigeria. Traffic Warden; Highway Policing. GPS-based Navigation Systems: Operation and Challenges; Trends and Future of Navigation Systems; Driverless Vehicles.

**Minimum Academic Standard**

Automobile Driving Laboratory, MOU with Federal Road Safety Corps and State Vehicle Inspection Office.

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 407: Power Trains and Transmission** (2 Unit, C, LH = 30, PH= 15**)**

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The aim of the course is to develop theoretical and practical kills in automotive transmission. Students will be exposed to theoretical and technical principles of the operation of automotive transmission. Students will be familiar with the concepts used in the design of automotive transmission.

**Course Objectives**

The objectives of the course are:

1. To describe the structure and operation of vehicle power train system,
2. To describe the concept, construction and principles of operation of various types of mechanical transmission,
3. To explain the principle of operation of hydrostatic devises and automatic transmission systems,
4. To demonstrate the differences between manual and automatic transmission systems,
5. To describe the procedure for the design of automotive transmission systems,
6. To describe the structure and operation of automotive differential and final drive.

**Learning Outcomes:**

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

1. Explain the structure and operation of the vehicle power train system,
2. compare the concept, construction and principle of operation of various types of mechanical transmission systems,
3. To analyze the principle of operation of hydrodynamic devices and automatic transmission systems,
4. Distinguish between manual and automatic transmission systems,
5. Explain the procedure for the design of automotive transmission systems,
6. Design different types of automotive transmission systems.

**Course Contents**

Overview of Vehicle Power trains System: Outlines of Power Trains, Power train functions, Power train layout and components, Main and Auxiliary functions, Requirements profile, Interrelations: Direction of rotation, Transmission Ratio and Torque, Road Profiles, Performance features of Vehicle Transmissions. Design trends in Transmission.

Matching engine and transmission: Road loads and axle loads, deriving condition diagram, Ideal transmission and engine-transmissions matching, Total ratio and overall gear ratio- Selecting the largest power- train ratio, Selecting the smallest power- train ratio, Selecting the intermediate gears- saw tooth profile, Geometrical gear steps, Progressive gear steps.

Start-up Devices: One-way clutch, Band clutch, Multi-disk clutch, Clutch Design and Analysis.

Hydrodynamic Clutches and Torque Converters: Principles, Characteristic curves of Hydrodynamic Clutches, Construction and operation of Torque Converter, Input/output characteristics, Design Considerations, Trilok Converter, Torque Converter test diagram, Interaction of engine and Trilok Converter, Numerical problems

Manual Transmissions: Manual Transmission Layouts and Components, Basic gear box construction, gear-sets with fixed axles, countershaft transmission and epicyclic gears, schemes for reverse gear. Transmission Power Flows, Numerical problems.

Gear shifting mechanisms and design of Synchronizers: Internal shifting mechanisms and External shifting mechanisms, Classification of shifting elements, synchronizer functional requirements, synchronizing process, design of synchronizers, alternative transmission synchronizers.

Automatic Transmissions: Gear shift mode, stepped and Continuously Variable Transmissions, synchronizer gear boxes, epicycloidal gear boxes, Car CVT’S: Van Doorne Continuously Variable Transmission (CVT) and Torotrak Continuously Variable Transmission (CVT). Design and analysis of planetary gear trains, Gear ratios and clutch engagement schedule, Clutch torques in steady state condition.

Differential and Final drives: Outline of differential theory-friction free differential, Differential with internal friction, Self-locking differential, final drives: formats, performance limits, transmission ratios. Differential gears, differential locks and locking differentials, types of self-locking differential, Numerical problems.

**Minimum Academic Standards**

Automobile systems and vehicle dynamics laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 407: Finite Element Analysis of Structures** (2 Units, C, LH = 30; PH= 15**)**

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will introduce students to finite element analysis 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 automotive engineering problems. Students will be required to undertake independent design projects.

**Course 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
4. Describe the application of finite element analysis techniques in solving problems related to heat transfer in automotive systems.

**Learning Outcomes**

After completing the course, students 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.

**Automotive Application:** Force distribution on different parts of automotive structure, design of the parts, static, dynamic and thermal analysis of the parts using finite element method. Material redistribution to minimize stresses and deflection.

**Minimum Academic Standards**

FEA Packages

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 408: Applied Aerodynamics** (2 Units, C, LH = 30; PH= 15**)**

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will introduce students to the fundamentals of fluid mechanics such as flow of inviscid and viscous fluids, laminar and turbulent flow in pipes and boundary layers and losses in pipe systems. Lift and drag forces on moving vehicles and aerofoil theory will be discussed. The course will also introduce concepts of incompressible-flow and compressible flow nozzles, Rayleigh and Fanno flow as well as external compressible flow around bodies including transonic and supersonic vehicles.

**Course Objectives**

The objectives of the course are to:

* + 1. Describe the principles and concepts of vehicle aerodynamics
    2. Describe procedure for deriving drag coefficient of vehicles
    3. Describe the application of aerodynamics in shape optimization of vehicles
    4. Describe the principles of vehicle handling based on aerodynamics approach
    5. Describe the use of wind tunnel technology and CFD analysis for automotive applications.

**Learning Outcomes**

After completing the course, students should be able to:

* + 1. Outline the principles and concepts of vehicle aerodynamics
    2. Explain procedure for deriving drag coefficient of vehicles
    3. Apply the principles of aerodynamics in shape optimization of vehicles
    4. Explain the principles of vehicle handling based on aerodynamics approach
    5. Apply wind tunnel technology and CFD analysis to solve problems related to automotive applications.

**Course Contents**

**Introduction:** Scope, historical developments, fundamental of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics.

**Aerodynamic Drag of Cars:** Cars as a bluff body, flow field around car, drag force, types of drag force, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles.

**Shape Optimization of Cars:** Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effects of gap configuration, effect of fasteners. Case studies on modern vehicles.

**Vehicle Handling:** The origin of forces and moments on a vehicle, lateral stability problems, methods to calculate forces and moments – vehicle dynamics under side winds, the effects of forces and moments, characteristics of forces and moments, dirt accumulation on the vehicle, wind noise, drag reduction in commercial vehicles and racing cars.

**Wind Tunnels for Automotive Aerodynamics:** Introduction, principle of wind tunnel technology, limitation of simulation, stress with scale models, full scale wind tunnels, measurement techniques, equipment and transducers, road testing methods, numerical methods. CFD analysis.

**Minimum Academic Standards**

Thermo-fluids laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 409: Dynamics and Control** (2 Units, C, LH = 30; PH= 15**)**

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

Dynamic systems are found everywhere, from musical instruments to transportation vehicles such as automobiles and aircraft. Even static civil structures such as bridges and buildings exhibit a dynamic response, which must be considered during design and construction of such systems. This course introduces the fundamental concepts of vibrating dynamical systems, from single degree of freedom systems through to continuous and multi-degree of freedom systems. The course will also addresses how to control dynamic systems using modern state-space control. Controller design using pole placement and optimal (LQR) control will be introduced. Computer aided control system design methodology applied to a real MIMO systems will be discussed.

**Course Objectives**

The objectives of the course are to:

Describe the principles and concepts of vehicle dynamics

Describe concepts of performance characteristics of road vehicles

Describe the principles and concepts of braking and handling characteristics of road vehicles

Describe the principles and concepts of ride characteristics of road vehicles

**Learning Outcomes**

After completing the course, students should be able to:

Explain the principles and concepts of vehicle dynamics

Outline the concepts of performance characteristics of road vehicles

Explain the principles and concepts of braking and handling characteristics of road vehicles

Explain the principles and concepts of ride characteristics of road vehicles.

**Course Contents**

**Introduction:** Introduction to vehicle dynamics, Vehicle coordinate system, Earth fixed coordinate system, Longitudinal, lateral and vertical vehicle dynamics, vehicle springing system - requirements, sprung mass and unsprung mass. **Performance Characteristics of Road Vehicles: Steady State Operation:** Various external forces acting on vehicle, Nature of the forces and factors affecting the forces, Tractive effort & Power available from the engine, Equation of motion, Maximum tractive effort, Weight distribution, Stability of vehicle on slope, Road performance curves, Acceleration, Gradibility & Drawbar Pull. **Transient Operation:** Inertia effect, Equivalent mass, Equivalent moment of inertia, Equivalent ungeared system, Time to produce synchronizing during gear change, Effect of engine flywheel on acceleration, Dynamics of vehicles on Banked tracks, Gyroscopic Effects, Net driving power. **Braking Characteristics**: Braking of vehicle - Braking applied to rear wheels, Front wheels and all four wheels, On straight & Curved path, Mass transfer & its effect, Braking efficiency & stopping distance, Reaction time & stopping time, Calculation of mean lining pressure & heat generation during braking. **Handling Characteristics**: Pitching, bouncing, yawing & rolling, wheel wobbling, Steering geometry, Fundamental condition for true Rolling. **Steady State Handling**: Slip angle, cornering power, Neutral steer, Under steer and over steer, Steady state response, Yaw velocity, Lateral Acceleration, Curvature response & Directional stability. **Transient Handling**: Basic principles, differential equations of motions. **Ride Characteristics**: Vibrations due to road roughness, vehicle ride model, Human response to vibrations, Two degree freedom model for sprung & unsprung mass, Two degree freedom model for pitch & bounce, Motion of vehicle on undulating road & Compensated suspension systems, roll centre & roll axis.

**Minimum Academic Standards**

Dynamics and Control laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 501: Vehicle Air-Conditioning** (2 Units, C, LH = 30; PH= 15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course is designed to expose students to the basic concepts, principles, types and components of vehicle air-conditioning system.

**Course Objectives**

The objectives of the course are:

1. To describe the fundamentals of air conditioning system,
2. To describe the automotive air cooling and heating system,
3. To describe the components of vehicle air conditioning system,
4. To describe the principles of air-conditioning control system,
5. To describe the construction and principles of operation of automatic temperature controls,
6. To conduct practical sessions on air conditioning system service and maintenance.

**Learning Outcomes**

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

1. Define the fundamentals of air-conditioning system,
2. Recall the concepts and principles of automotive air cooling and heating system,
3. Identify the components of vehicle air-conditioning system,
4. Explain the principle of operation of vehicle air-conditioning control system,
5. Explain the construction and principles of operation of automatic temperature controls,
6. Diagnose, service and repair automotive air-conditioning system.

**Course Contents**

Air Conditioning Fundamentals:Purposes of heating, ventilation, and air conditioning. Environmental concerns and ozone layer depletion. Location of air conditioning components in a car. Schematic layout of a vehicle refrigeration system. Psychrometry – Basic terminology and Psychrometric mixtures- Psychrometric Chart

Automotive Cooling and Heating System:Vehicle refrigeration system and related problems. Fixed thermostatic and orifice tube system. Variable displacement thermostatic and orifice tube system. Vehicle air conditioning operation. Heating system.

Compressors: Types of compressors, compressor clutches, Compressor clutch electrical circuit. Condensers, evaporators, expansion devices. Evaporator temperature and pressure controls. Refrigerant hoses, connections and other assemblies.

Air-Conditioning Controls, Delivery System and Refrigerants:Types of Control devices. Preventing compressor damage. Preventing damage to other systems. Maintaining driveability, Preventing overheating ram air ventilation. Air delivery components. Control devices, vacuum controls. Handling refrigerants; Discharging, charging & leak detection. Refrigeration system diagnosis.

Automatic Temperature Control:Different types of sensors and actuators used in automatic temperature control. Fixed and variable displacement temperature control. Semi-automatic controller design for fixed and variable displacement type air conditioning system.

System Servicing and Testing: Special tools for servicing vehicle air conditioning. Diagnosing components and air conditioning systems. Diagnosing cooling and air delivery systems. Automatic temperature control system diagnosis and service.

**Minimum Academic Standards**

Refrigeration and Air-conditioning Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 502: Alternative Vehicle Propulsion Systems** (3 Units, C, LH = 30; PH= 15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course is designed to familiarize students with the construction and operation of vehicle propulsion systems.

**Course Objectives**

The objectives of the course are:

i. Describe the principles and concepts of vehicle energy and fuel consumption,

ii. Describe electric and hybrid vehicle propulsion system,

iii. Describe the principles of operation of vehicle propulsion systems,

iv. Explain different types of fuel cells for automotive applications,

v. Conduct design exercises on electric and hybrid vehicle propulsion system.

**Learning Outcomes**

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

1. Recall the principles and concepts of vehicle energy and fuel consumption,
2. Classify electric and hybrid vehicle propulsion system,
3. Explain the principles of operation of vehicle propulsion systems,
4. Analyze different types of fuel cells for automotive applications,
5. Design an electric or hybrid vehicle propulsion system.

**Course Contents**

Vehicle Energy and Fuel Consumption:Vehicle energy conversion pathways. Vehicle energy losses and performance analysis. Mechanical energy demand in driving cycles. Methods and tools for the prediction of fuel consumption.

Electric and Hybrid-Electric Propulsion Systems: Electric propulsion systems. Hybrid-electric propulsion systems. Electric motors.

Batteries: Battery parameters-power requirement of electric vehicles. Different types of batteries. Battery charging, Charger design, Quick charging devices. Battery modelling. Super-capacitors. Electric power links. Torque couplers. Power split devices.

Non-electric Hybrid Propulsion Systems: Short Term Storage Systems. Flywheels. Continuously variable transmissions (CVT). Hydraulic accumulators. Hydraulic pumps/motors. Pneumatic hybrid engine systems.

Fuel Cells:Fuel cell characteristics. Fuel cell types. Connecting cells in series. Fuel cell propulsion systems**.** Fuel cell electric vehicles. Fuel cell hybrid vehicles.

Supervisory Control Algorithms: Heuristic control strategies. Optimal control strategies.

Design Considerations for Electric and Hybrid Vehicles:Aerodynamic rolling resistance. Transmission efficiency. Vehicle mass. Electric vehicle chassis and body design considerations. Heating and cooling systems. Controllers, power steering, tyre choice. Wing mirror, aerials and luggage racks.

**Minimum Academic Standards**

Automobile systems and vehicle dynamics laboratory; Automobile Workshop

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 503: Noise, Vibration and Harshness** (2 Units, C, LH = 30, PH = 15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will provide students with the opportunity to acquire knowledge on the degree of noise, vibration and harshness experienced by passengers in vehicles.

The course will equip students with the skills required to design automobiles of improved comfort and enhanced safety.

**Course Objectives**

The objectives of the course are to:

1. Describe the fundamental concepts and principles of vehicle sound and noise,
2. Describe the noise measurement and instrumentation techniques,
3. Describe the principles and concepts of sound fields and room acoustics,
4. Describe the different types of vehicles internal and external noise,
5. Describe the sources of vibrations in vehicles,
6. Describe vibration measurement and control techniques.

**Learning Outcomes**

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

1. Explain the fundamental concepts and principles of vehicle sound and noise,
2. Explain noise measurement and instrumentation techniques,
3. Recognize the principles and concepts of vehicle noise, vibration, and harshness,
4. Identify the sources of noise and vibration and their transmission paths in cars under different driving conditions,
5. Explain vibration measurement and control techniques,
6. Use the principles and concepts in the design of vehicle systems.

**Course Contents**

Fundamentals of Sound:Direct and indirect vehicle sound generation mechanism. Acoustic variables, basic attributes of sound. Wave equation, types of sound fields. Measures of sound: sound pressure, sound intensity and sound power. Combining sources: dB arithmetic, standing wave, and impedance. Human hearing: frequency versus sound pressure level. Loudness: phones and sones as noise descriptors; Weighting networks, various noise metrics for road noises.

Noise measurements and instrumentation: Measuring microphones, sound level meter, time and frequency weighting. Sound spectra. Octave band analysis, order analysis and waterfall plot. Various types of acoustic testing chambers. Sound power measurement from sound pressure (Free field method, Reverberant field method, Semi-Reverberant field method and comparison method). Two- microphone probe for measuring sound power. Sound intensity

Sound fields and room acoustics:Characterizing sound sources. Sound fields. Various approaches to modelling sound sources. Transmission loss (TL) and Insertion loss (IL); Reverberation time and Acoustic Absorption Coefficient; Effects of leaks on barrier and TL of composite barriers; measurement Absorption Coefficient and Transmission loss (TL).

Vehicle Interior and Exterior Noise:Internal noise sources in vehicles such as engine noise. Aerodynamic (wind) noise, brake noise; squeak, rattle and tizz noises. Acoustic isolation, acoustic absorption and damping material solutions. Exterior noise sources in vehicles such as air intake systems and exhaust systems; Tyre noise.

Sources of Vehicle vibration:Power train and Engine vibrations; driveline vibrations; chassis and suspension vibrations; Control strategies; Human response to vehicle vibrations, concept of harshness; subjective and objective evaluation of vehicle harshness.

Vibration Isolation and Control:Damping of vibrations; vibration isolation and absorption. Design of a vibration absorbers. Unconstrained and constrained layer damping treatment, add on dampers and stiffeners, Introduction to Active Vibration Control.

Vibration Measurement and Instrumentation: Definition of modal properties, modal analysis theory. FE & experimental modal analysis. Transducers and accelerometers. Excitation sources, impact excitation, shaker excitation, excitation signals. Application of modal analysis. Laser-based vibration measurements. Analysis and presentation of vibration data.

**Minimum Academic Standards**

Dynamics and Control laboratory; Automobile Workshop

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 504: CAD/CAM** (3 Units, C, LH = 30, PH = 15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will provide students with the opportunity to develop skills and competencies in CAD/CAM techniques.

**Course Objectives**

1. Describe the principles and concepts of computer aided design and computer aided manufacture,
2. Describe the principles and elements of production, organization and inspection techniques,
3. Conduct individual exercises involving the use of CAD software, finite element analysis, and rapid prototyping techniques,
4. Organize group exercises involving automotive product design, analysis, materials selection, manufacture, and testing,
5. Describe the elements of computer aided manufacturing process,
6. Describe the principles and concepts of product data management.

**Learning Outcomes**

After completing the course, students should be able to:

1. Recall the concepts and principles of CAD/CAM,
2. Explain the principles and elements of production, organization, and inspection techniques,
3. Demonstrate competencies in the use of CAD software and rapid prototyping techniques,
4. Apply the relevant skills in automotive product design, analysis, materials selection, manufacture, and testing,
5. Explain the advances in computer aided manufacturing,
6. Explain the principles of product data management.

**Course Contents**

Computer Aided Design (CAD): Production Drawings created from 2-D and 3-D CAD systems covering solid and surface modelling, mass properties, and finite element analysis. Rapid Prototyping and Computer Aided Manufacturing (CAM) Software.

Production, Organisation, and Inspection Techniques:Master Schedule, Aggregate Planning, MRP, OPT, Group Technology, Principles of Lean Manufacturing, CMM, Shadow Graph, Surface Finish Measurement, Gauging, Standards and Calibration, NDT. Quality Assurance: ISO 9000 Systems.

Individual Design Study: Use of CAD Software to Integrate with Finite Element Analysis for design verification. Transfer of the Model into Computer Aided Manufacturing. Use of Software, Rapid Prototyping Techniques.

Group Design Study:Current Design Practice, Analysis, Manufacture, Product Testing, Regulations, Materials and Processes.

Computer Aided Manufacturing:Operation and Sequence Planning. Machine Definition, NC sequences, and Post Processing.

Product Data Management:Overview of the role of PDM. Research through Case Studies. Rapid Prototyping, Overview of Methods and Applications, Manufacturing Techniques.

**Minimum Academic Standards**

CAD/CAM Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 505: Vehicle Body and Chassis Engineering** (2 Units, C, LH = 30, PH = 15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will impart knowledge in the construction of vehicle body and chassis.

**Course Objectives**

The objectives of the course are to:

i. Describe the details of car and bus bodies,

ii. Describe the details of vehicles body used for commercial purposes,

iii. Describe the properties of materials used in the manufacture of vehicles body,

iv. Explain the procedure for the design of vehicle body,

v. Demonstrate the dynamics of vehicle steering mechanism,

vi. Describe the principles of operation of vehicle suspension system.

**Learning Outcomes**

At the end of the course the student will be able to:

1. Explain the details of the body and chassis of different types of vehicles,
2. Recall the concepts of the design and construction of vehicle body and chassis,
3. Identify the properties of materials used in the manufacture of vehicle body and chassis,
4. Outline the procedure for the design of vehicle body and chassis,
5. Solve numerical problems relating to vehicle steering dynamics and suspension mechanisms,
6. Design an automotive body or chassis under concrete situations.

**Course Contents**

Car Body Details: Types of car bodies, visibility, regulations, driver’s visibility, methods of improving visibility, safety design, constructional details of roof, under floor, bonnet, boot, wings etc, Classification of coach work.

Bus Body Details: Minibus, single and double decker, two level, split level and articulated bus. Bus body lay-out, floor height, engine location, entrance and exit location, Seating dimensions. Constructional details: Frame construction, double skin construction, and types of metal section used. Conventional and integral type of construction.

Commercial Vehicle Details: Types of body, flat platform, drop side, fixed side, tipper body, tanker body, light commercial vehicle body types. Dimensions of driver's seat relation to controls. Drivers cab design.

Body Materials, Trim Mechanisms: Steel sheet, timber, plastic, GRP, and properties of materials. Corrosion - anticorrosion methods, scalation of paint and painting process. Body trim items. Body mechanisms.

Body Loads and Design of Vehicle Bodies: Idealized structure, structural surface, shear panel method. Symmetric and asymmetrical vertical loads in car. Longitudinal loads, different loading situations.

Design of Vehicle Bodies: Vehicle layout design, preliminary design, and safety. Load distribution on vehicle structure. Calculation of loading cases, stress analysis of bus body structure under bending and torsion. Stress analysis in integral bus body. Design of chassis frame. Rules and regulations for body. Recent safety measures. Testing of body.

Steering Dynamics: Kinematics Steering, Vehicles with More Than Two Axles, Vehicle with Trailer, Steering Mechanisms, Four wheel steering, Steering Mechanism Optimization, Trailer - Truck Kinematics, Numerical examples.

Suspension Mechanisms: Solid Axle Suspension, Independent Suspension, Roll Center and Roll Axis, Car Tire Relative Angles, Toe, Caster Angle, Camber, Trust Angle, Suspension Requirements and Coordinate Frames, Kinematics Requirements, Dynamic Requirements, Wheel, wheel body and tyre, Coordinate Frames, Caster Theory, Numerical examples.

**Minimum Academic Standards**

Automobile systems design maintenance and testing laboratory; Automobile Workshop

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 506: Automotive On-Board Diagnostics** (2 Units, C, LH = 15, PH = 30)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will develop skills and competencies in automotive onboard diagnostic systems. The course will develop skills and competencies in automotive onboard diagnostic systems. The skills acquired in the course will empower students to become competent in diagnosis and repair of complex automotive systems. The course will be taught in collaboration with automobile maintenance organizations in Kano. Students shall be motivated to be entrepreneurial, innovative, and creative, to enable them to establish their maintenance enterprises.

**Course Objectives**

The objectives of the course are:

i. Describe the operation and structure of vehicle computer system and electronic control units,

ii. Describe the function of sensors and actuators found on automobile,

iii. Explain the structure and operation of automotive diagnostic system and sub-systems,

iv. Demonstrate practical applications of on-board diagnostic (OBD II) tools,

v. Conduct practical exercises using diagnostic scanners and link connectors,

vi. Explain the structure and operation of professional scanning tools such as ELM platforms, CReader, Autoboss V30, Mercedes MB Star, Launch X431Master and Heavy-Duty,

vii. Conduct exercises on practical diagnostics and basic components identification.

**Learning Outcomes**

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

i. Recall the operation and structure of vehicle computer system and electronic control units,

ii. Explain the function of sensors and actuators found on automobile,

iii. Recognize the structure and operation of automotive diagnostic system and sub-systems,

iv. Show competencies in the application of on-board diagnostic (OBD II) tools,

v. Demonstrate practical skills in using diagnostic scanners and link connectors,

vi. Differentiate the structure and operation of professional scanning tools such as ELM platforms, CReader, Autoboss V30, Mercedes MB Star, Launch X431 Master and Heavy-Duty,

vii. Demonstrate competencies in practical diagnostics and basic components identification.

**Course Contents**

Vehicle Computer System and Electronic Control Units (ECUs): Engine control unit. Transmission control unit. Chassis control unit. Body control unit.

Sensors and Actuators: Engine sensors and actuators. Transmission sensors and actuators. Chassis sensors and actuators. Body sensors and actuators.

Diagnostic System:Diagnostic system with reference to the powertrain, body, chassis and communication. Vehicle Diagnostic Sub-System: Break-down of the four classifications (Powertrain, Body, Chassis and Communication) of vehicle diagnostic system to their constituent components. Powertrain (engine [emission and ignition], and transmission). Body (immobilizer and intrusion controls; steering electrics; supplementary restraint system; instrument cluster; heater, ventilation and air-conditioning [HVAC] and climate control). Chassis (suspension electrics, ABS and break electrics). Communication (CAN [Controller Area Network], LIN [Local Inter-Connect Network] and other vehicle inter-connecting networks).

On-Board Diagnostic Version Two (OBD II): History of OBD II. Diagnostic menu, reading the diagnostic codes, erasing codes and PIDs (Parameter Identifications: Generic and Diagnostic Equipment Manufacturers’ PIDs).

Diagnostic Scanners and Link Connectors: Elaborate practical sessions with numerous contemporary DIY. Professional scanning tools (ELM platforms, CReader, Autoboss V30, Mercedes MB Star, Launch X431Master and Heavy-Duty, etc.).

Practical Diagnostics and Basic Components Identification: Practical vehicle lay-out and diagnostic tool menu. Use of diagnostic tools for basic adaptation programming.

**Minimum Academic Standards**

Automobile systems design maintenance and testing laboratory; Automobile Workshop

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 507: Advances in Automotive Technology** (2 Units, C, LH = 30)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course will provide the student with the opportunity to recognize the future trend in the development of automobile. The course will provide the student with the opportunity to recognize the future trend in the development of automobile. The course is intended to introduce students to contemporary and cutting-edge automotive engineering and technology.

**Course Objectives**

The objectives of the course are to:

i. Discuss the challenges and prospects of the automotive industry of the future,

ii. Describe the automotive fuel cell technology and its advantages/disadvantages,

iii. Describe the features of 21st century automotive engines,

iv. Discuss the 42-Volt System and its application in the automotive industry,

v. Discuss the principles and construction of electrical and hybrid vehicles,

vi. Describe the principles and operation of integrated starter alternator,

vii. Discuss the principles and concepts of X-bye wire technology,

viii. Discuss the principles of the contemporary vehicle systems.

**Learning Outcomes**

At the end the course the student will be able to:

1. Recall the challenges and prospects of the future automotive industry,
2. Explain the automotive fuel cell technology and its advantages/disadvantages,
3. Identify the features of the 21st century automotive engines,
4. Contrast the 42-Volt systems and its application in the automotive industry,
5. Explain the principles of operation and construction of electrical and hybrid vehicles,
6. Explain the principles and operation of integrated starter alternator,
7. Criticize the principles and concepts of X-bye wire technology,
8. Discuss the latest technology and development trend in automobile technology

**Course Contents**

Future of Automotive Industry:Challenges and concepts for the 21st century; Crucial issues facing the industry and approaches to meet these challenges; Nigerian Automotive Industry

Fuel Cell Technology:what is fuel cell; types; advantages; current state of the technology; potential and challenges; advantages and disadvantages of hydrogen fuel.

Latest Engine Technology Features: Advances in diesel engine technology. Direct fuel injection gasoline engines. Diesel particulate emission control. Throttling by wire. Variable valve timing and method used to effect it. Electromagnetic valves. Cam-less engine actuation.

42-Volt System: Need; benefits; potentials and challenges; technology implications for the automotive industry; technological evolution due to adoption of 42-volt systems.

Electrical and Hybrid Vehicles: Types of hybrid systems; objective and advantages of hybrid systems. Current status and future development and prospect of hybrid vehicles.

Integrated Starter Alternator: Start-stop operation; power assist; regenerative braking; advanced lead acid batteries; alkaline batteries; lithium batteries; development of new energy storage systems; deep discharge and rapid charging ultra-capacitors.

X-By Wire Technology: What is X-By wire technology? Advantage over hydraulic systems. Use of automotive micro controllers. Types of censors. Use of actuators in an automobile environment.

Vehicles Systems: Constantly variable transmission; benefits; brake by wire; advantages over power braking system. Electrical assist steering; steering by wire; advantages of steering by wire. Semi-active and fully active suspension system. Advantages of fully active suspension system.

**Minimum Academic Standards**

Automobile systems design maintenance and testing laboratory; Automobile Workshop, CAD Studio

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 508 Facilities Design & Ergonomics**  (2 Units; C; LH = 30; PH= 15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

This course is designed to provide an introduction to facility layout and location. It will provide the students with importance of facility layout, activity relationships, space and personnel requirements, manufacturing flow patterns and layout procedure types. Students will also be introduced to vehicle ergonomics standards, vehicle crashworthiness and occupant safety, driving discomfort and their causes etc.

**Course Objectives**

The objectives of the course are to:

1. Describe the principles and concepts facility design in automotive industry;
2. Describe the principles and concepts ergonomics in automotive industry;
3. Describe the principles and concepts of best practices in development of automotive industry,
4. Describe the principles and concepts ofvehicle ergonomics & safety

**Learning Outcomes**

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

* + 1. Recognize the concepts and principles of facilities design in automotive industry
    2. Explain the concepts and principles ergonomics in automotive industry;
    3. Illustrate the use of best practices in in the conception and development of automotive industry,

1. Explain the principles and concepts ofvehicle ergonomics & safety

**Course Contents**

**Facility Design:** Importance of facility layout, activity relationships, space and personnel requirements, manufacturing flow patterns, layout procedure types - both construction and improvement algorithms, manual and computerized layout techniques, modular facilities, single and multiple facility location, material handling systems design, and warehouse operations.

**Vehicle Ergonomics & Safety:** Concept and purpose, Risk factors: personnel, job and environmental workstation design; rules for establishing an ergonomics program. Anthropometry; Biomechanics of Motion; Driving Discomfort and their Causes; Disorders and Injuries; Automotive Seat Design; Seats for Drivers with disabilities. Vehicle Ergonomics Standards.

**Minimum Academic Standards**

Automobile systems design maintenance and testing laboratory; Automobile systems and vehicle dynamics laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 509: Automobile Transport and Fleet Management** (2 Unit, C, LH = 30**)**

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

This course will provide students with the required competencies to own and manage a fleet of vehicles. The skills acquired in the course can empower students with entrepreneurial mindset to create jobs and wealth in the country. The course will be delivered in collaboration with the Kano State Ministry of Transport.

**Course Objectives**

The objectives of the course are to:

1. Describe the principles and concepts of automobile transport,
2. Describe the principles of passenger transport operations,
3. Describe the principles of goods transport operations,
4. Describe the procedure for vehicle registration in Nigeria,
5. Describe the principles and concepts of fleet management,
6. Explain the procedure for vehicle insurance.

**Learning Outcomes**

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

1. Define the principles and concepts of automobile transport,
2. Outline the principles of passenger and goods transport operations,
3. Identify the problems and opportunities in automobile transport and fleet management in Nigeria,
4. Analyze the challenges and potential of automobile transport and fleet management in Nigeria,
5. Evaluate the automobile transport sector of Nigeria,
6. Develop a cost effective and sustainable automobile transport and fleet management strategy for Nigeria.

**Course Contents**

Introduction: Necessity for making Acts and rules on motor vehicles; Formats of the acts; rules and titles; Definitions: articulated vehicle; axle weight; certificate of registration; driver; conductor; license; contract carriage; stage carriage; dealer; goods; goods carriage; gross vehicle weight; heavy goods vehicle; invalid carriage; learners license.

Passenger Transport Operation: Structure of passenger transport organizations, Problems on fleet management, Fleet maintenance, Bus & Crew Scheduling, significance of Motor Transport Workers act, personnel & training - training for drivers & conductors, Public relations, passenger amenities, advertisement work, Theory of fares, Basic principles of fare charging, Management Information System (MIS) in passenger transport operation.

Goods Transport Operation: Structure of goods transport organizations, scheduling of goods transport, Freight calculations, Management Information System (MIS) in goods transport operation, storage & transportation of petroleum products.

Vehicle Registration: Necessity; area of registration; time given for registration; format and documents to be attached and fees; period of registration; renewal; suspension; Temporary and permanent registration; vehicle fitness; registration for embassy vehicles; Migration of vehicle from one state to other; Hire purchase; lease; transfer of registration on sale; Transfer of ownership.

Logistics: Definition of fleet; types of fleet-luxury cars; buses; trucks; cash vans; fire-fighting vehicles etc; Management; supervisory; training and staffing; Driver; conductor and Mechanics hiring – duties; Vehicle operations-productivity and control; Fleet maintenance programs; tyre maintenance; productivity and control; Budget activity; Fleet management and data processing; Procurement and disposal; labour relations; Fitness of vehicles.

Motor Insurance: Types; scope; limitations; liability of insurance Cos; insurance documents-claim form; estimate and bills; Necessity for insurance against third party risk; Requirements and limits of liability of insurance policy; Procedure to be followed for settlement of a claim after an accident; Surveyor and loss assessor; Surveyors report; Certificate of insurance: transfer; Compensation to third party deaths.

**Minimum Academic Standard**

Automobile workshop, Automobile Transport Laboratory

**Bayero University Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

# **BUK-TAE 510 Heat and Mass Transfer** (3 Units; C; LH= 45; PH= 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:

1. to visualize and explore the three types of heat transfer: conduction, convection, and radiation.
2. to understand 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. how various factors affect heat transfer, including temperature differentials, duration of contact, surface area, and type of material.
4. heat transfer enhancements techniques
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 Contents**

**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**

Thermo-fluids Laboratory

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 521: Advanced Manufacturing Technology** (2 Units; O; LH = 30)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course is designed to equip students with both theoretical and practical skills in advanced manufacturing technology application required to produce automotive engineering graduates. It will also expose students to the state-of-the-art manufacturing techniques.

The course will provide early broad–based training in general science required for advanced study in automotive engineering. This will contribute to achieving the mission of Bayero University; “training of high-quality graduates” and contribute to building workforce capable of creating jobs and wealth.

**Course Objectives**

The objectives of the course are to:

1. Describe the concepts and principles of the advanced manufacturing technologies,
2. Discuss the principles and concepts of non-traditional machining technologies;
3. Discuss the features and application of graphics standards,
4. Describe the application of AI in CAD/CAM/CIM, reverse engineering and rapid prototyping

**Learning Outcomes**

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

1. Recall the concepts and principles of the advanced manufacturing technologies,
2. Explain the principles and concepts of non-traditional machining technologies;
3. Outline the features and application of graphics standards,
4. Apply AI in CAD/CAM/CIM, reverse engineering and rapid prototyping

**Course Contents**

Integrated automation, computers and managerial challenges; modern cutting tools and tool management, CAPP, high speed machining, precision machining;

Non-traditional machining: EDM, ECM, USM, PAM, EBM, AJM, WJM, Explosive forming and LBM.

Graphics standards - CAD and CAE, Computer networking, GT concept, FMS, CIM, Computer aided Quality Control, CMM, Application of AI in CAD/CAM/CIM., Reverse Engineering, Rapid Prototyping and Tooling.

**Minimum Academic Standards**

CAD/CAM/CIM Laboratory; CAD, CAE Software

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 522: Robotics and Robot Applications** (2 Units; O; LH = 30)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Course Overview**

The course is designed to equip students with both theoretical and practical skills in robotics and robot application required to produce automotive engineering graduates. The course will also provide students with the opportunity to develop competence in the application of robotics in automotive engineering.

The course will provide early broad–based training in general science required for advanced study in automotive engineering. This will contribute to achieving the mission of Bayero University; “training of high-quality graduates” and contribute to building workforce capable of creating jobs and wealth.

**Course Objectives**

The objectives of the course are to:

1. Describe the theory and principles of robotics;
2. Explain the importance, and demonstrate the use of robots in the manufacturing process of vehicles.
3. Demonstrate the principles of robot design for an automotive industry in Nigeria.

**Learning Outcomes**

At the end the course the student will be able to:

1. Recall the theory and principles of robotics;
2. Explain the importance & use of robots in the manufacturing process of vehicles.
3. Use the principles to design a robot for an automotive industry in Nigeria.

**Course Contents**

Fundamentals of Robot: Definition; robot anatomy: co-ordinate systems; work envelope; types and classification: specifications: pitch; yaw; roll; joint notification; speed of motion; payload: robot parts and their functions: need for robots: different applications;

Robots Drive Systems and End Effectors: Pneumatic Drives: hydraulic drives: mechanical drives: electrical drives: D.C Servo Motors; stepper motor; A.C Servo motors: salient features; application and comparison of all these drives.

Sensors: Requirements of sensor; principles and applications of sensors: Position sensors:

Piezo electric sensor, LVDT, resolvers, optical encoders, pneumatic position sensors; range sensors: triangulation principle, structured, lightning approach, time of flight, range finders, laser range meters, proximity sensors: inductive, hall effect, capacitive, ultrasonic, optical proximity sensors; touch sensors: binary sensors, analog sensors, wrist sensors, compliance sensors, slip sensors.

Machine Design: Camera; frame; grabber; sensing and digitizing image data: signal conversion; image storage; lighting techniques; image processing and analysis: data reduction; segmentation; feature extraction; object recognition; other algorithms; application: inspection; identification; visual serving and navigation.

Robot Kinematics: Forward kinematics; inverse kinematics and differences; forward kinematics and reverse kinematics of manipulators with two; three degree of freedom (in 2 dimensional); four degree of freedom (in 3 dimensional): deviations and problems

Robot Programming: Teach pendent programming; lead through programming; robot programming; languages: VAL programming: motors commands, sensors commands, end effecter commands and simple programs.

Implementation and Robot Economics: RGV; AGV; implementation of robots in industries: various steps; safety considerations for robots operations; economic analysis of robots: payback method; EUAC method; rate of return method.

**Minimum Academic Standards**

CAD/CAM/CIM Laboratory; CAD, CAE Software

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 523: Special Purpose Vehicles** (2 Units; O; LH = 15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Overview**

The course is designed to equip students with both theoretical and practical skills in special purpose vehicles application required to produce automotive engineering graduates The course will also expose students to the construction and operation of vehicles use for special applications.

The course will provide early broad–based training in general science required for advanced study in automotive engineering. This will contribute to achieving the mission of Bayero University; “training of high-quality graduates” and contribute to building workforce capable of creating jobs and wealth.

**Course Objectives**

The objectives of the course are to:

1. Describe the structure and principles of operation of land clearing machines and earth moving machines
2. Describe the structure and principles of operation of industrial vehicles
3. Describe the structure and principles of operation of military and combat vehicles
4. Describe the structure and principles of operation of farm tractors and machinery
5. Describe the structure and principles of operation of mobile cranes and miscellaneous vehicles

**Learning Outcomes**

Upon completing this course students will be able to:

1. Explain the structure and principles of operation of land clearing machines and earth moving machines
2. Give description of the structure and principles of operation of industrial vehicles
3. Discuss the structure and principles of operation of military and combat vehicles
4. Explain the structure and principles of operation of farm tractors and machinery
5. Outline the principles of operation of mobile cranes and miscellaneous vehicles

**Course Contents**

**Land Clearing Machines:** Bush cutter, stumpers, Tree dozer, Rippers. **Earth Moving Machines:** Bulldozers, cable and hydraulic dozer. Crawler trach, running and steering gears, scrapers, drag and self-powered types – Dump track and dumpers – Loaders, single bucket, multi bucket and rotary types- Power and capacity of earth moving machines. Scrapers and Graders: Scrapers, elevating graders, self-powered scrapers and graders. Shovels and Ditchers: Power shovel, revolving and stripper shovels – drag lines – ditchers – Capacity of shovels. **Industrial Vehicles:** Constructional features, capacity and stability of jib cranes. Vibratory compactors, forklifts. Towing vehicles. **Military and Combat Vehicles:** Ride and stability characteristics, power take off, special implementations. Special features and constructional details of tankers, gun carriers and transport vehicles, bridge builders, communication vehicles. **Farm Tractors and Machinery**: Classification; Layout; load distribution; engine; transmission and drive line; steering; braking system; wheels and tyres; hydraulic system; auxiliary systems; draw bar; PTO shaft; Harrow disc; sprayer; seeder. **Mobile Cranes**: Basic characteristics of truck cranes; stability and design features; control systems and safety devices. **Miscellaneous Vehicles:** Tracked vehicles; articulated vehicles; multi-axle vehicles.

**Minimum Academic Standards**

Automobile Workshop

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 524: Computational Fluid Dynamics** (2 Units; O; LH = 30)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Overview**

The course is designed to equip students with both theoretical and practical skills in computational fluid dynamics application required to produce automotive engineering graduates. The course will also introduce students to numerical modelling and its application in the field of heat and fluid flow.

The course will provide early broad–based training in general science required for advanced study in automotive engineering. This will contribute to achieving the mission of Bayero University; “training of high-quality graduates” and contribute to building workforce capable of creating jobs and wealth.

**Course Objectives**

The objectives of the course are to:

1. Describe the concepts and principles governing differential equation and finite difference methods
2. Describe the concepts and principles of conduction heat transfer
3. Discuss the principles of convection heat transfer and finite element method
4. Describe the concepts and principles of incompressible fluid flow
5. Describe the concepts and principles of turbulence models

**Learning Outcomes**

Upon completion of this course, the students should be able to:

1. Explain the concepts and principles governing differential equation and finite difference methods
2. Solve practical problems involving conduction heat transfer
3. Explain the principles of convection heat transfer and finite element method
4. Solve practical problems involving the concepts and principles of incompressible fluid flow
5. Develop turbulence models of fluid flow.

**Course Contents**

**Governing Differential Equation and Finite Difference Method:** Classification, Initial and Boundary conditions – Initial and Boundary Value problems – Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test. **Conduction Heat Transfer:** Steady one-dimensional conduction, two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems. **Convection Heat Transfer and FEM:** Steady One-Dimensional and Two-Dimensional Convection – diffusion, Unsteady one-dimensional convection – diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – solution of steady heat conduction by FEM – Incompressible flow – simulation by FEM. **Incompressible Fluid Flow:** Governing Equations, Stream Function – Vortices method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach. **Turbulence Models:** Algebraic Models – One Dimension model, K – є Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

**Minimum Academic Standards**

Thermo-fluids Laboratory; CFD Software

**Bayero University, Kano (BUK)**

**Engineering**

**Mechanical Engineering**

**B. Eng. Automotive Engineering**

**BUK-TAE 525: Vehicle Body Work and Painting** (2 Units; O; LH =15; PH= 15)

**Senate-approved relevance**

The philosophy is to produce automotive 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. The introduction of B.Eng. Automotive Engineering in Bayero University is in accordance with the BUK Strategic Plan 2016-2020 (Objective No.i Goal No.1).

**Overview**

This course will enable students to expand skills in auto body repair and refinish. Students will learn the importance of safe work practices in a body shop. Students will develop a basic understanding of automobile construction and will learn basic repair techniques not only limited to refinishing, metal repair, structural analysis, welding, plastics repair, and trim and hardware. Students will learn to identify and use power and hand tools necessary to perform basic repairs.

This course will offer a combination of in-class instruction and hands-on shop activities and provide early broad–based training in general science required for advanced study in automotive engineering. This will contribute to achieving the mission of Bayero University; “training of high-quality graduates” and contribute to building workforce capable of creating jobs and wealth.

**Course Objectives**

The objectives of the course are to:

1. Describe and demonstrate different techniques of vehicle body work,
2. Discuss the classification of paints and coatings for automotive application,
3. Describe different types of automotive painting processes,
4. Discuss the electro deposition coating technology,
5. Describe the requirements and design procedure for automotive paint shop,
6. Describe the techniques for paint defect identification and prevention.

**Learning Outcomes**

Upon completion of this course, the students should be able to:

i. Demonstrate practical skills in vehicle body work using different techniques,

ii. Recall the classification of paints and coatings for automotive application,

1. Explain different types of automotive painting processes,

iv. Explain electro deposition coating technology for automotive application,

1. Outline the requirements and design procedure for automotive paint shop,
2. Apply the techniques for paint defect identification and prevention.

**Course Contents**

Vehicle Body Work: Use of Hand and Power Tools. Techniques of Metalworking (Rough out, Kinking, Cold shrinking, Heat shrinking, Finishing, etc.). Body Preparation. Plastic Fillers. Fiberglass and SMC Repair. Sanding. Application of primers.

Paints and coatings, Classification of Paints and coatings, Scope of Automotive Paint Industry, Current Paint Manufacturers.

Automotive Painting Processes: General Painting Process, Pretreatment, Sand and Shot blasting Sequence of Treatment, Degreasing, Activation, Zinc Phosphating, Baking Oven, Passivation, Pre-Treatment of multi-metal car bodies, Pre-Treatment of Plastic Parts, Car Body Pre Treatment Lines, Primer Surface, Sealing and Underbody Protection, Top Coats and Clear Coats.

Electro Deposition (ED) Coatings: Types of ED coatings. Difference between Anodic and Cathodic ED Paint Process. Layout of an ED Paint Shop. Design of Car ED Lines. General Functions and Equipment of an Electro-coat Line.

Paint Shop Design and Quality Aspects: Typical Layout of an Automotive Paint Shop. Designing of an Automotive Paint Shop. Quality Aspects: measurement of paint thickness, measurements of basic paint properties (Viscosity, scratch resistance, stone chip resistance), leak and shower test. Shop safety practices.

Paint Defects during Applications and their Prevention: Paint Defects, Why defect appears and How to repair the defects, Prevention of paint defects.

**Minimum Academic Standards**

Automobile Workshop