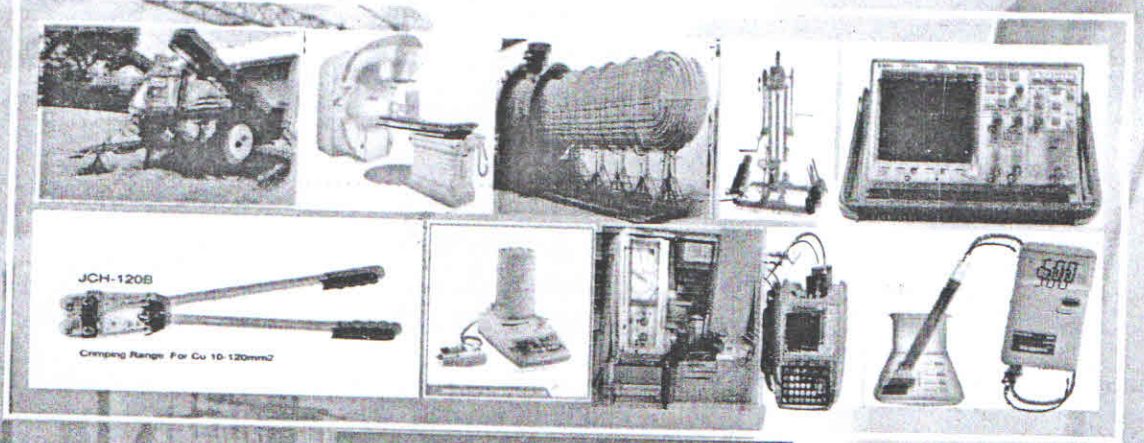
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INTRODUCTION TO ENGINEERING DISCIPLINES

(With Relevant Information on Engineers in Society)



EDITORS:
Professor D. S. Ogunniyi
Professor J. O. Olaoye
Dr. J. O. Aweda
Dr. M. O. Sunmonu

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(Second Edition)

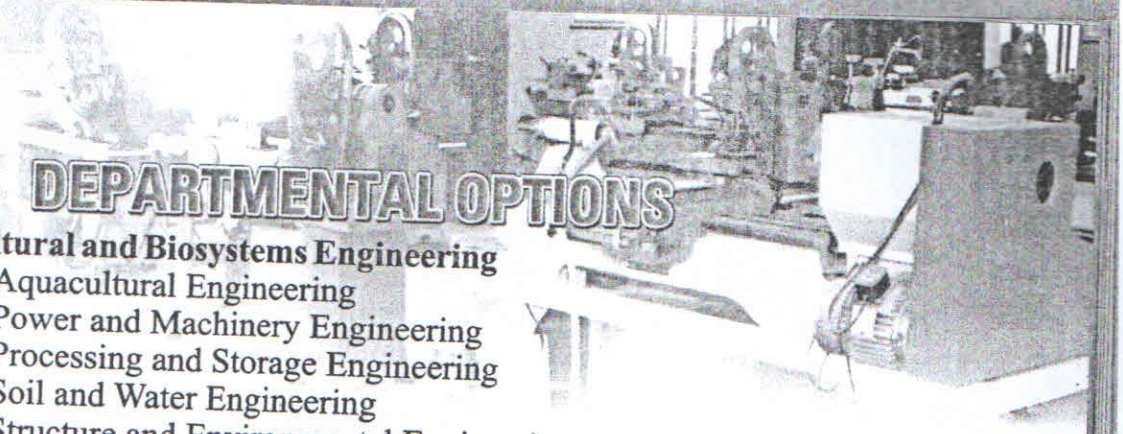
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APRIL, 2019



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DEPARTMENTAL OPTIONS

(a) Agricultural and Biosystems Engineering

1. Aquacultural Engineering
2. Power and Machinery Engineering
3. Processing and Storage Engineering
4. Soil and Water Engineering
5. Structure and Environmental Engineering

(b) Biomedical Engineering

1. Biomedical Instrumentation and Micro/Nano Systems
2. Cell and Tissue Engineering
3. Computational Bioengineering

(c) Chemical Engineering

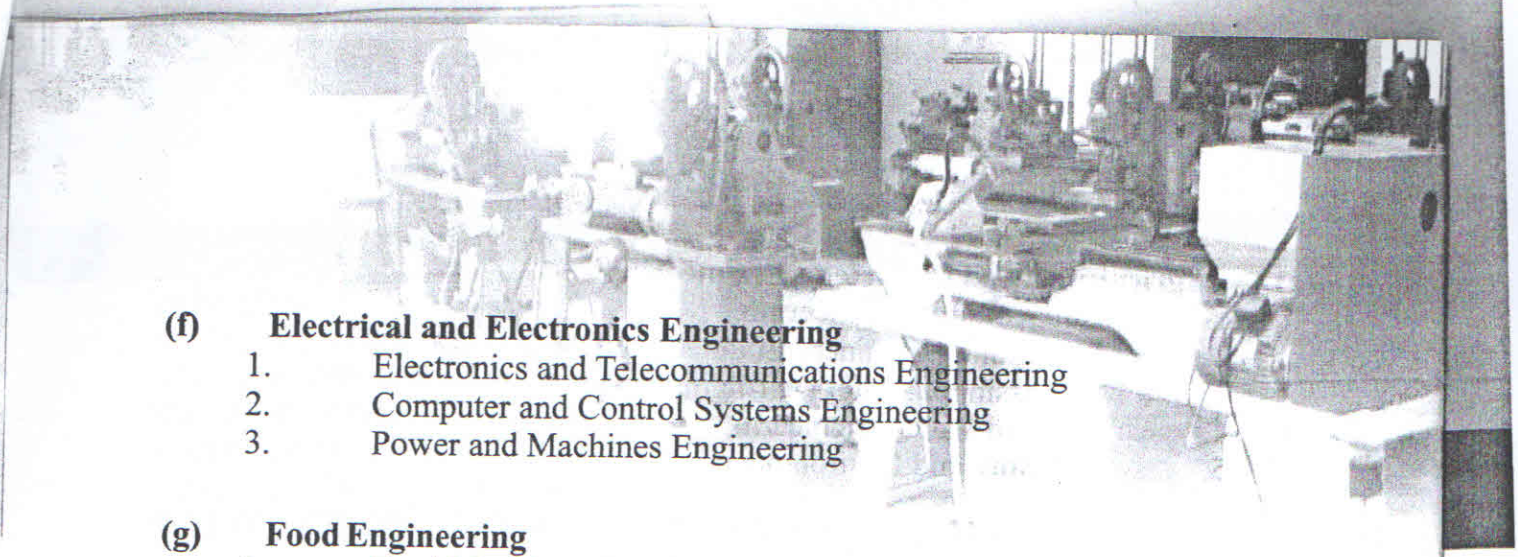
1. Processes Engineering
2. Biotechnology/Biomedical Engineering
3. Petroleum Engineering
4. Environmental Engineering
5. Process Control and Modelling
6. Reaction Engineering
7. Polymer Engineering
8. Thermodynamics, Energy and Exergy Analysis

(d) Computer Engineering

1. Embedded Systems and Automation
2. Computer Communications and Networks
3. Computer System Architecture
4. Cryptography and Information Security
5. Mobile Computing and Distributed Systems
6. Software Engineering
7. Computational Science Engineering
8. Computer Vision and Robotics
9. Digital Signal Processing

(e) Civil Engineering

1. Geotechnical Engineering
2. Structural Engineering
3. Transportation Engineering
4. Water Resources Engineering
5. Materials Engineering
6. Construction Engineering and Management
7. Environmental Engineering



(f) Electrical and Electronics Engineering

1. Electronics and Telecommunications Engineering
2. Computer and Control Systems Engineering
3. Power and Machines Engineering

(g) Food Engineering

1. Food Machinery/Equipment/Systems Design
2. Food Process Design and Development
3. Bioproduct Processing and Engineering Option
4. Food Storage, Distribution, Environmental Analysis

(h) Materials and Metallurgical Engineering

1. Wear and Corrosion
2. Advanced Materials Engineering
3. Metallurgical Engineering
4. Mineral Processing and Extractive Metallurgical Engineering
5. Material Engineering
6. Material production Engineering

(i) Mechanical Engineering

1. Automobile/Vehicle System Engineering
2. Combustion and Environment Engineering
3. Heat Transfer, Thermodynamics and Energy Systems Engineering
4. Manufacturing Engineering
5. Mechanical Design and Mechanics Engineering
6. System Dynamics and Control Engineering
7. Mechatronics Engineering
8. Materials and Metallurgy, and Processing Engineering
9. Fluid Mechanics/Environmental Fluid Mechanics Engineering
10. Machine Design and Solid Mechanics Engineering
11. Welding and Joining
12. Automation and Control Engineering
13. Biomedical and Fluid Mechanics Engineering

(j) Water Resources and Environmental Engineering

1. Water Resources Engineering
2. Environmental Engineering

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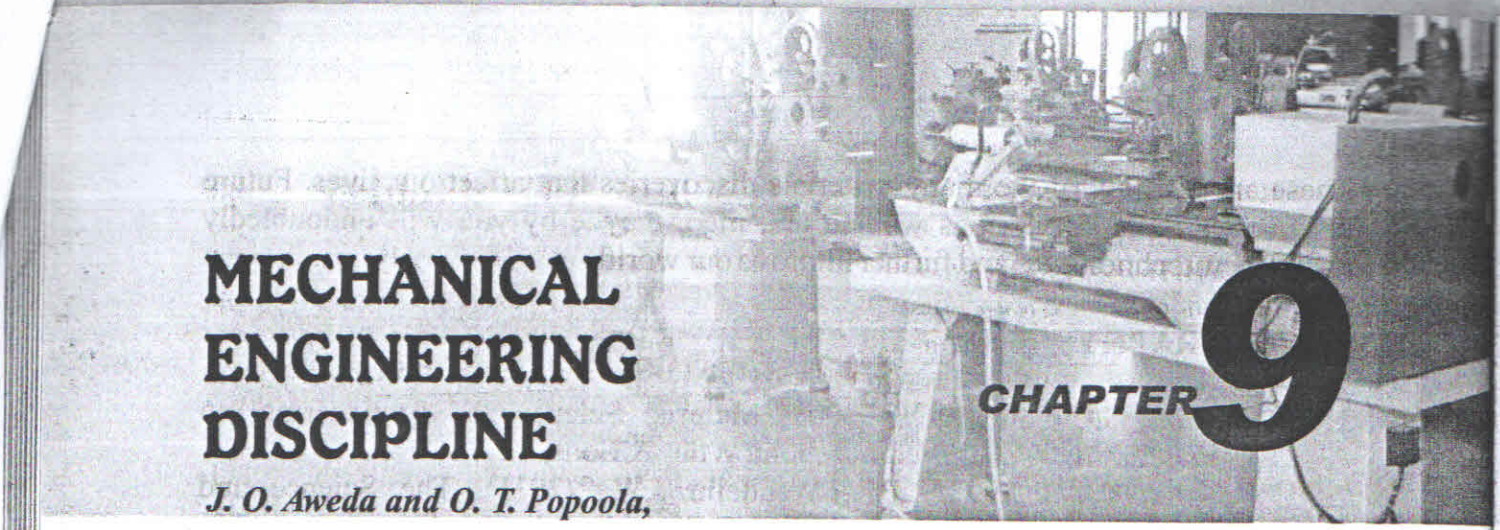
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MECHANICAL ENGINEERING DISCIPLINE

CHAPTER 9

J. O. Aweda and O. T. Popoola,

COURSE SYNOPSIS

Mechanical Engineering

Introduction to mechanical engineering discipline: Definition of mechanical engineering. Specializations/Options in Mechanical engineering, Use of various equipment in Mechanical engineering for different operations/processes. Research and teaching equipment in mechanical engineering. Prospects and job opportunities in mechanical engineering. Relevant professional bodies in mechanical engineering. Role of mechanical engineers in advancement of humanity.

9.1 INTRODUCTION TO MECHANICAL ENGINEERING DISCIPLINE

9.2 DEFINITION

Engineering is the profession in which knowledge of the mathematical and natural sciences previously gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind. Therefore, Mechanical engineering is one of the largest and oldest disciplines and broadest of all engineering disciplines. Mechanical engineering applies the principles of mechanics and energy to the design of machines and devices thus referred to as energy and motion.

Mechanical engineering derives its practice from the need to design and manufacture everything from small unit parts and devices to large systems. The one skill that is the Mechanical Engineer's exclusive domain is the ability to analyze and design objects and systems with motion. The role of a Mechanical Engineer is to take a product from an idea to the marketplace. In order to accomplish this, a broad range of skills are needed. The Mechanical Engineer needs to acquire particular skills and knowledge that will enable him practice. The Mechanical Engineer needs to understand the related forces and the thermal environment of the product, its parts, or its subsystems will encounter during operation in order to design them for functionality, aesthetics and the ability to withstand service loads and the thermal environment they will be

subjected to in operation. The Engineer determines the best way to manufacture the devices and ensure they will operate without failure by first subjecting the design to various design/failure criteria.

Since these skills are required for virtually everything that is made, this makes Mechanical Engineering to be the broadest and most diverse of engineering disciplines. Mechanical Engineers play a central role in such industries as automotive (from the car chassis to its every subsystem: engine, transmission, sensors, suspension, braking system, exhaust and many more); aerospace (airplanes, aircraft engines, control systems for airplanes and spacecraft); biotechnology (implants, prosthetic devices, fluidic systems for pharmaceutical industries); computers and electronics (disk drives, printers, cooling systems, semiconductor tools); micro-electromechanical systems (sensors, actuators, micro-power generation); energy conversion (gas turbines, wind turbines, solar energy, fuel cells); environmental control (heat ventilation and air conditioning (HVAC), refrigeration, compressors); automation (robotics, data and image acquisition, recognition, control); manufacturing (machining, machine tools, mechanical forming, prototyping, micro-fabrication); materials (casting, fabrication, corrosion).

Mechanical Engineering deals with anything that moves (this is in line with the general belief of Mechanical Engineers that when it moves it is Mechanical), including the human body, a very complex machine. The Mechanical Engineer learns about materials, solid and fluid mechanics, thermodynamics, heat transfer, control, instrumentation, design and manufacturing to understand mechanical systems. In addition, Mechanical Engineer must be well grounded in the required engineering treatments that should be given each component part of the design before it is put into use after fabrication.

Specialized Mechanical engineering subjects include biomechanics, energy conversion, laser-assisted materials processing, combustion, microfluidic devices, fracture mechanics, nano-mechanics, mechanics of machines, micro-power generation, tribology (friction and wear), heat engineering, vibrations, graphics, materials and metallurgy. Other related courses required before becoming a graduate of Mechanical Engineering are industrial engineering, engineering management, engineering law and many others as specified in the criteria for graduation of each institution.

The coverage of the Mechanical engineering discipline allows students a variety of career options beyond some of the industries. Regardless of the particular path the Mechanical Engineers hope for themselves after graduation, the knowledge gained will have provided them with the creative thinking that allows them to design an exciting product or system, the analytical tools to achieve their design goals, the ability to overcome all constraints and the teamwork needed to design, market and produce a system.

9.3 SPECIALIZATIONS /OPTIONS IN MECHANICAL ENGINEERING

The under listed are the areas of specialization in the field of mechanical engineering:

9.3.1 Automobile/Vehicle System Engineering

An aspect of mechanical engineering is the design of automobiles or vehicle system engineer. The emphasis is on the design of more environmentally benign vehicles that can provide transportation while using fewer resources. Innovations in this field require competence in vehicle dynamics, propulsion and engine concepts, control of power transmission, and construction of lightweight with ease of manufacture of structures and systems. Fueled power systems, including electric drives, are also studied with the aim of minimizing fuel consumption.

9.3.2 Combustion and Environment Engineering

Combustion is widely used for energy generation, propulsion, heating and waste disposal, as well as for many other applications. Mechanical Engineers are often heavily involved with the design of combustion systems (internal combustion engines, gas turbines, furnaces, etc.) and deal with aspects of combustion ranging from increasing efficiencies to reducing pollutant emissions. With the current increased emphasis on reducing pollutants while efficiency is maintained or increased, the efforts of Mechanical Engineers in designing and improving combustion systems are becoming more important.

9.3.3 Heat Transfer, Thermodynamics and Energy Systems Engineering

This area of interest emphasizes the fundamentals of heat transfer and thermodynamics and their application to the design of advanced engineering systems. The study introduces the fundamental processes of heat transfer and thermodynamics in complex engineering systems to enable more efficient, cost effective and reliable designs with less environmental pollution and impact. An understanding of heat transfer and thermodynamics is required for the design of efficient, cost-effective systems for power generation (including advanced energy conversion systems), propulsion (including combustion engines and gas turbines), heat exchangers, industrial processes, refining and chemical processing. This area of interest is important to many industries such as aerospace, defense, automotive, metals, glass, paper and plastic as well as to the thermal design of electronic and computer packages.

9.3.4 Manufacturing Engineering

Manufacturing is the process of converting raw materials into products. The emphasis in the manufacturing program is to provide hands-on experience with computer-integrated processes and manufacturing methods called Computer Numerical Controlled (CNC) machines. Workshops have manufacturing equipment for conventional and non-traditional machining, three-dimensional measurement

and plastic injection moulding. Computer-oriented manufacturing (or Computer Aided Manufacturing) is also an emphasis of the program. A Manufacturing Engineer will have a solid background in manufacturing processes (machine tools) and systems as well as in statistics, design, controls and applications of microprocessors.

9.3.5 Mechanical Design and Mechanics Engineering

The creation and improvement of products, processes, or systems that are mechanical in nature are the primary activities of a professional design Mechanical Engineer. The development of a product, from concept to detailed design, manufacturing process selection and planning, quality control and assurance and life-cycle considerations are areas of study and specialization in the area of mechanical design. Solutions to such major social problems as environmental pollution, lack of mass transportation and of raw materials and energy shortages will depend heavily on the engineer's ability to create new types of machinery and mechanical systems. The Engineer-designer or the design engineer must have a solid and relatively broad background in the basic physical and engineering sciences and have the ability to solve a variety of problems. In addition to having technical competence, the designer must be able to consider the socio-economic consequences of a design and its possible impact on the environment. Product safety, reliability, aesthetics and economics are other considerations of the design/mechanics engineer.

9.3.6 System Dynamics and Control Engineering

Mechanical Engineers are increasingly concerned with the performance of integrated dynamics systems in which it is not possible to optimize component parts without considering the overall system. System dynamics and control specialists are concerned with the modeling, analysis and simulation of all types of dynamic systems and with the use of automatic control techniques to change the dynamic characteristics of systems with the aim of making work much easier to accomplish.

9.3.7 Mechatronics Engineering

Mechatronics is the integration of mechanical, electrical and computer technologies into the design of complex products. Mechatronics builds on core-mechanical engineering-competency in dynamics, vibrations, controls, nonlinear systems and robotics. The basic aim of a Mechanical Engineer is to replace/reduce human efforts in equipment operation for greater efficiency and productivity.

9.3.8 Materials and Metallurgy, and Processing Engineering

This area of specialization until recently has been an aspect of Mechanical Engineering. Even though in few higher Institutions of learning, it is in a separate Department, this area of engineering is very important in Mechanical Engineering as well. It consists of a comprehensive series of courses in metallurgy, materials, heat treatment, casting, welding, cold and hot forming. Nonmetallic materials, including plastics and ceramics and composites such as fiberglass and sandwich structures are also considered in this area of Mechanical Engineering. Professionals in this area study the behaviour of materials and composites in relation to their properties while in serve.

9.3.9 Fluid Mechanics/Environmental Fluid Mechanics Engineering

The courses in this area of specialization deal with a broad range of applications of the principles of thermodynamics and fluid mechanics, with emphasis on topics of industrial significance to aerodynamics, internal fluid flows with heat and mass transfer, turbomachinery and flows in the natural environment such as plumes in air and effluents in water.

9.3.10 Machine Design and Solid Mechanics Engineering

The courses offered in this area of specialization range from those which provide the mathematical and physical basis of the subject matter through to those which are largely applied in nature. Subjects treated are: mechanics (including vibrations); theories of elasticity, plasticity and fracture; machine design and design optimization.

9.3.11 Welding and Joining Specialization Engineering

Welding and joining processes are used to fabricate almost all manufactured products. New automated manufacturing methods have made welding and joining more important than ever before. The courses in this specialization are intended to prepare students to work in all areas related to welding and joining. The knowledge of materials' behaviour and heat transfer are very important for this option of engineering.

9.3.12 Automation and Control Engineering

The courses in this area of specialization are designed to provide the student with an understanding of the principles and control of production processes, the application of computers to the manufacturing activity and the organization of production. Topics treated are: automation, metal forming, numerical control of machine tools, applications of fluid power and industrial noise control. This area of Mechanical engineering is a prominent part of the mechanical portion of the Mechatronics Option.

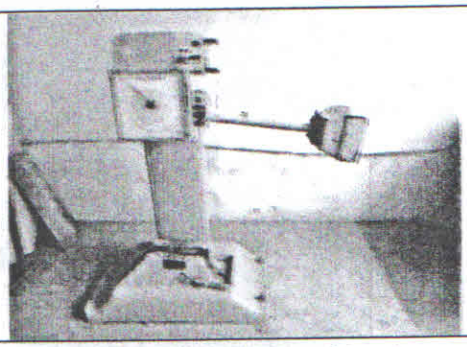
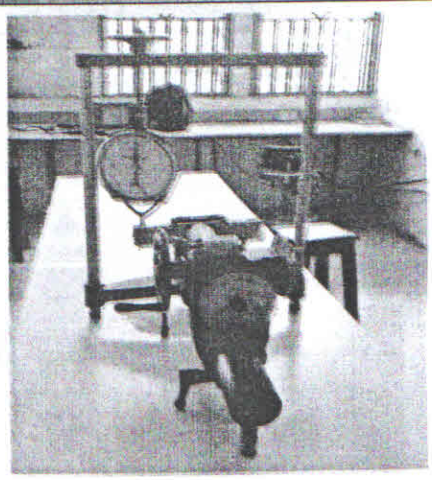
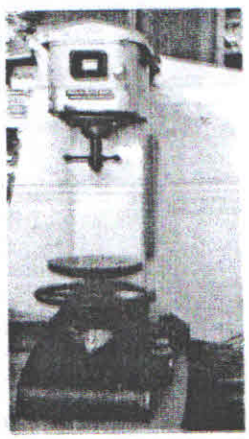
9.3.13 Biomedical and Fluid Mechanics Engineering

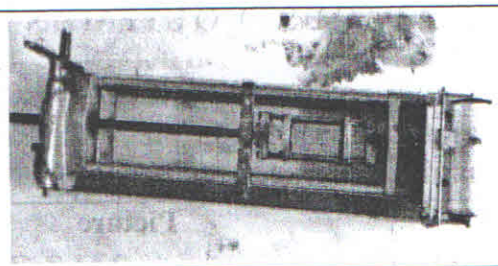
This field of study is based on the fundamentals of fluid mechanics and their broad range of applications in the biomedical and engineering disciplines. Areas of research include aerodynamic flow around transportation vehicles, flow in combustion engines, blood circulation in the body and its potential role in the regulation of normal physiological function and in the development of disease, groundwater and atmospheric flows and their implications for pollutant transport and environmental concerns and flow in combustion engines and other energy systems with considerations of efficiency and environmental impact.

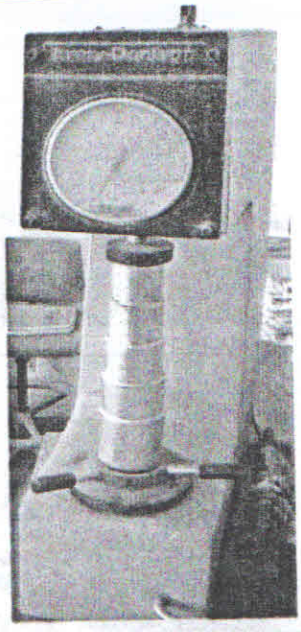
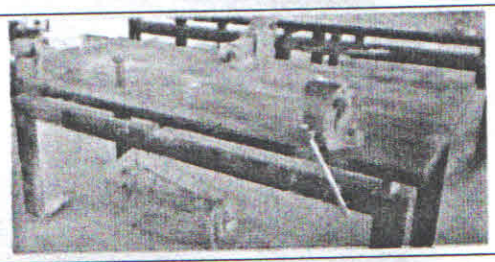
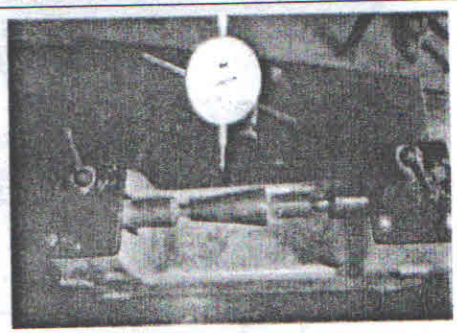
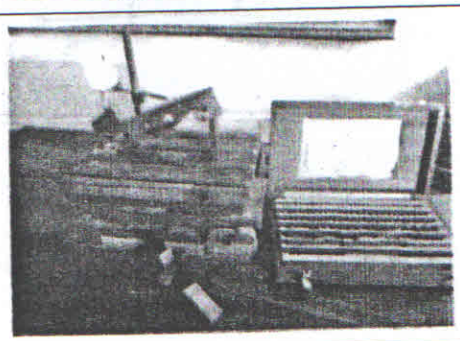
Although all of the designated options are open to mechanical engineering students or intending students, in practice only a few of these options may be taken conveniently at undergraduate level in the Universities. All of these options depend on each Institution. The option to offer depends on what each Institution offers in their curriculum. At the postgraduate level, several of these options are available in most Universities.

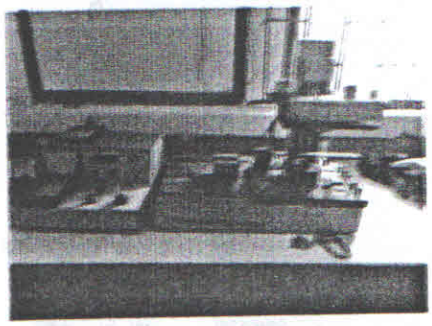
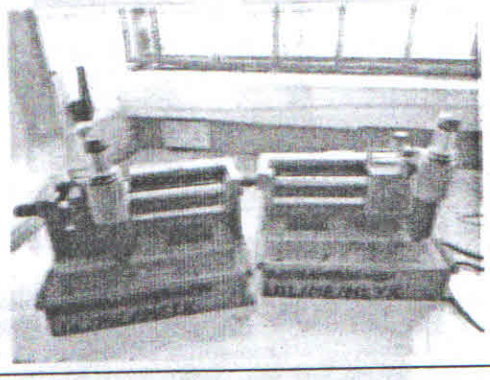
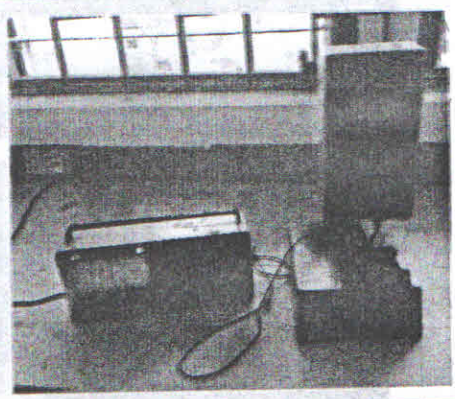
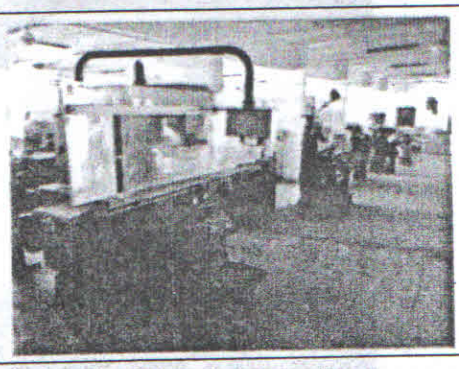
9.4 USE OF VARIOUS EQUIPMENT IN MECHANICAL ENGINEERING

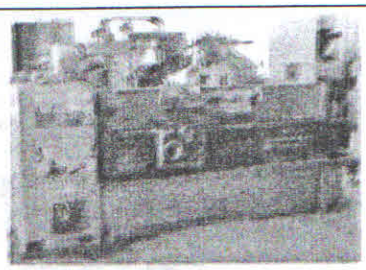
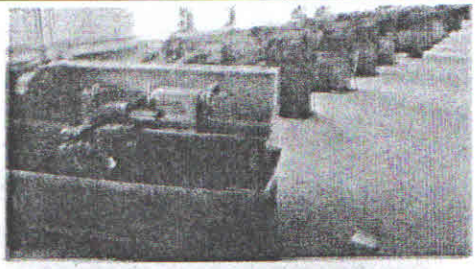
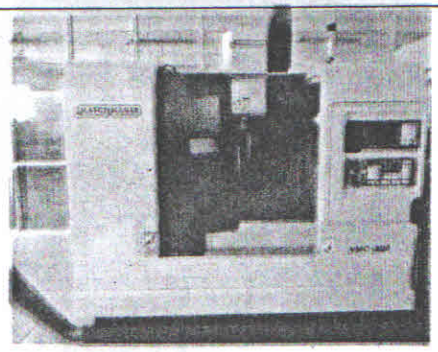
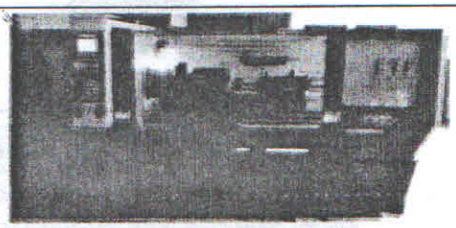
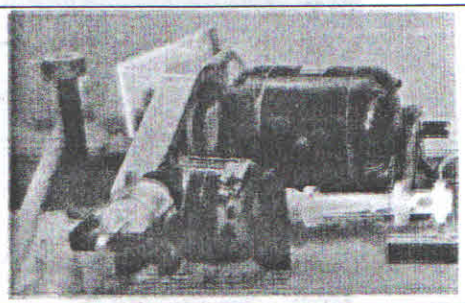
Table 9.1: Equipment, Implements and Instruments Used for Various Operations in Mechanical Engineering

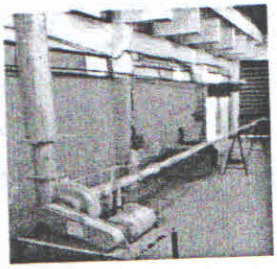
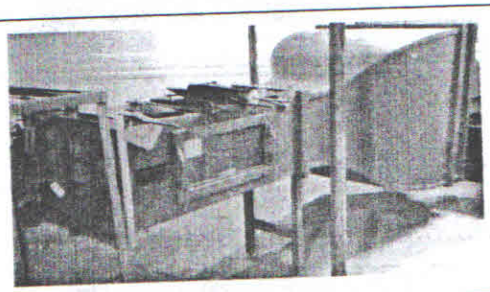
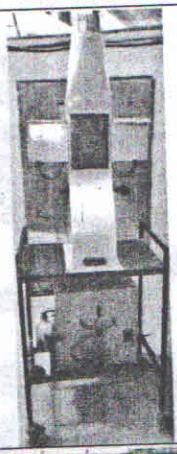
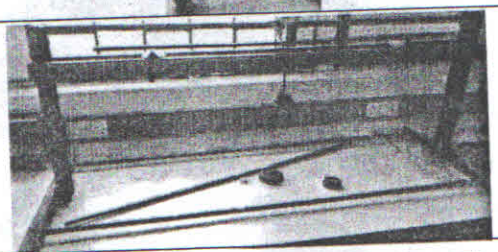
S/No.	Name of Equipment	Picture	Uses
1.	Impact Testing Machine		Used to determine the impact of a material
2.	Torsion Tester		Used for the determination of torsion in material
3.	Hardness Testing Machine		For the determination of material hardness

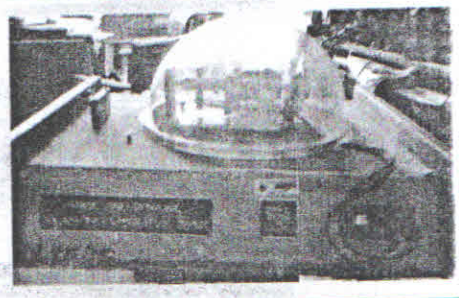
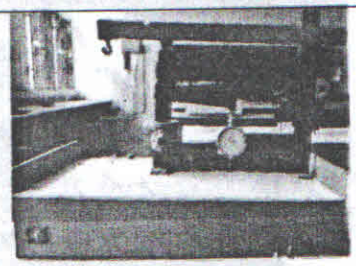
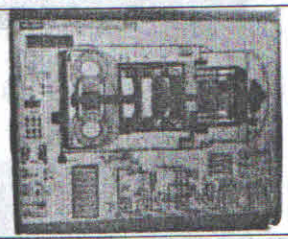
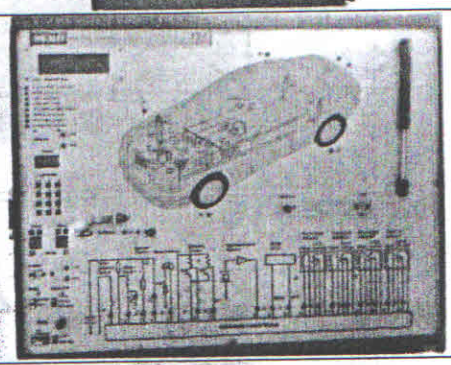
4.	Tensometer Type "W"		Horizontal tensile measuring device
5.	Testometric AT50		Universal testing machine for tensile and compression testing of material
6.	Jomminy End Quench Tester		For testing hardenability of material

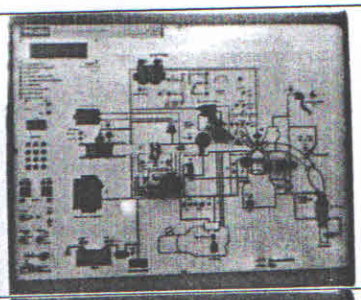
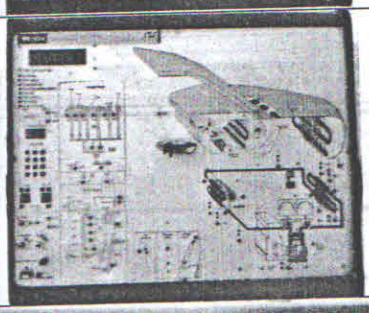
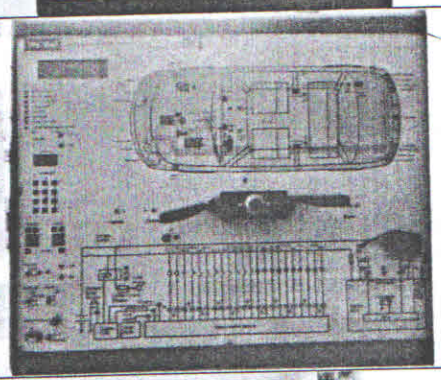
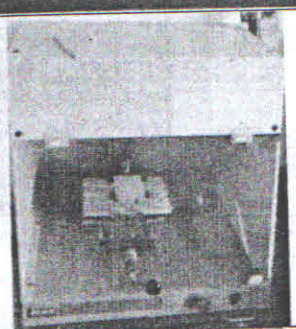
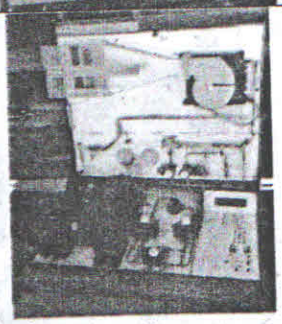
7.	Hardness Testing Machine Avery-Denison		For hardness testing of material
8.	Bench Vice		Used for various mechanical bench works
9.	Precision Measuring Instrument		For determining the concentricity and parallelism of tapered gauges
10.	Sine Centre		Used to determine the taper angle and smooth surface of slip gauges

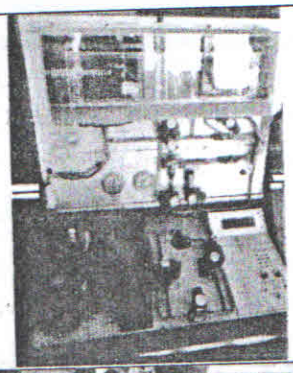
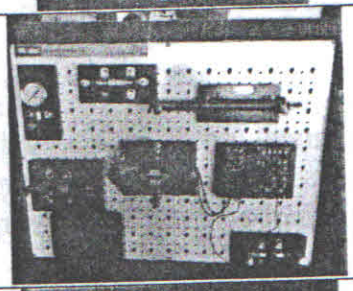
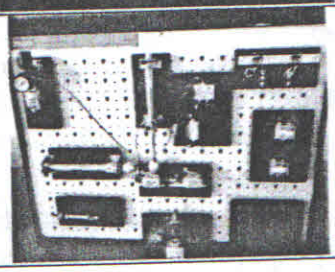
11.	Talysurf 10 A112/1260E		For surface texture and profile measurement determination
12.	Linear Vernier Microscope		For checking crystals structure in metals
13.	Electronic Sigma Comparator 230-05		For determining the smoothness of slips gauges
14.	Milling Machine 4AMKV		For milling and polishing of material surfaces

15.	Universal Lathe Machine GS260		For different lathe operations
16.	Set of Conventional Lathe Machines VF145		For lathe operations
17.	Matchmaker VMC 820		CNC milling machine
18.	CNC Evolution AJE 310		CNC lathe machine
19.	Compressible Flow Bench		Used to determine and understand the fundamentals of compressible fluid flow

20.	Flow Pipe Apparatus TE50/5544		Used to investigate the phenomena of laminar, translational and turbulent flows in pipe systems
21.	Wind Tunnel TE44/5287		Used in aerodynamic research for the study of the effects of air movement in solid objects
22.	Smoke Generator TE80/5501		To examine the flow pattern around a body or over its surface
23.	Beam Deflection Apparatus		Used for the determination of plasticity of metal and Young modulus
24.	Gyroscope: TM 104		Demonstrates stability or reference direction in navigation system (orientation and angular velocity demonstrator

25.	Static and Dynamic Balancing Apparatus TM 102		For static and dynamic balancing rotating object
26.	Centrifugal Force Apparatus TM105		Used to demonstrates that centrifugal force varies with square of speed, rotating mass and radius of gyration
27.	Creep Measuring Apparatus With Heating Chamber		For measuring creep in material with or without being subjected to temperature
28.	TPS 3579: Transmission Simulator		To demonstrate transmission system of vehicles
29.	TPS 3577: Suspension Simulator		The device Demonstrates the suspension system of automobiles

30.	TPS 3546: Multipoint Injection Demonstrator		Demonstrates the injection system in vehicles
31.	TPS 3574: Car Air Conditioning and Climate Control Simulator		It demonstrates the air conditioning and climate in vehicles
32.	TPS 3541: Light and Signalling Demonstrator		The device is used to demonstrate signaling light in a an automobile
33.	TPS3910: CNC Mini-Milling Machine		Demonstrates milling operation
34.	TPS3950/3954 Professional Air-Conditioning:		Demonstrates air conditioning system

35.	TPS3950/3953 Industrial Refrigeration		Demonstrates industrial refrigeration system
36.	TPS3860: Hydraulic Training System		Demonstrates hydraulic system in machines
37.	TPS: 3810: Pneumatic Training System		Demonstrates pneumatic system in machines

9.5 PROSPECTS AND JOB OPPORTUNITIES IN MECHANICAL ENGINEERING.

Mechanical Engineer: Job description

The diverse Mechanical engineering field can be divided into a variety of ways in terms of job functions. Some of the most common jobs related to this area of technology, but not limited are:

Product Design

Developing products ranging from biomedical devices to gasoline-powered engines and processing equipment is the duty of Mechanical Engineer. A Mechanical Engineer designs devices that use mechanical motion.

Research and Development

Discovering new solutions to human needs and improving on existing methods of accomplishing tasks is the main goal of research and development.

Manufacturing
Manufacturing Engineers develop machines that process materials into products. Designing and building machines and systems of machines that improve operating efficiency is of prime importance.

Systems Management
Mechanical Engineers with specialization in system management oversee operations of a large system, which could be power plant or any industrial system, as well as supervising the people who work there.

Energy
Planning how energy is generated, stored and transmitted is the duty of those in energy option of Mechanical engineering. Industries that produce and deliver electrical power, such as natural gas, oil and alternative energy, employ mechanical engineers to develop more fuel-efficient equipment and appliances.

Financial Institutions
Mechanical Engineers work as equipment maintenance, system maintenance engineer and initiating small scale businesses.

Government Agencies
The Mechanical Engineers are good in the area of project, maintenance and technical officers in charge of utility equipment and construction/fabrication of new ones. The Engineers also serve as planners for the implementation of government policies.

Research Institutes
In higher or specialized research Institutes trying to find ways of doing things much easier or discovering totally new things for the good of humanity.

Consultancy Services
The Mechanical Engineer sets up a private consultancy firm or in an organized firm. Some consulting firms are in the areas of Mechanical and Electrical, plant and hydraulic machines, mechanical design, drawing and drafting, 3D and 2D modeling, Computer Aided Design (CAD). Others include project management, technical services, power generation, transmission and distribution, oil and gas. Other areas of consultancy services include mechanical services, piping and plumbing of water or chemical flow, refrigeration and air conditioning, septic tank, overhead storage tank. Mechanical Engineer can engage in material testing, fabrication, foundry practice, computer simulations and many more in both private and public organizations either as Engineer or Managers.

9.6 RELEVANT PROFESSIONAL BODIES IN MECHANICAL ENGINEERING

There are many Professional bodies in Mechanical engineering. In addition to being professional bodies, some are saddled with the duties of regulating the practice of engineering and can therefore, discipline erring members and firms for professional misconduct. These are local and international Professional bodies. Among these are: .

1. Council for the Regulation of Engineering in Nigeria, COREN
2. The Nigerian Society of Engineers, NSE
3. Nigerian Institution of Mechanical Engineers, NIMechE
4. Industrial Engineering Division of NSE
5. Automobile Engineers Institute,
6. Petroleum Division of NSE
7. Institute of Appraisal and Cost Engineering, Division of NSE
8. Engineering Institute of Canada
9. Canadian Nuclear Society
10. American Society of Mechanical Engineers, ASME
11. Institution of Engineers India
12. European Federation of National Engineering Association

9.7 ROLE OF MECHANICAL ENGINEERS IN THE ADVANCEMENT OF HUMANITY

Mechanical Engineer contributes to the development of humanity and his immediate environment in diverse ways which include:

1. Development and production of equipment for small and medium entrepreneurs,
2. Research and development of new equipment for improved productivity,
3. Standardization of equipment produced locally or imported into the country,
4. Undertake research into man-machine relationship with the objective of improving human comfort,
5. Formulation of appropriate standard in Mechanical Engineering adaptable to the host country for ease of operation and maintenance of such equipment and
6. Research into the local content in the areas of material usage and development.

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Relevant Websites

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10. http://worldwide.erau.edu/?sc_camp=514C792EBFEC42FAA5D91D8365E4DE7A&utm_campaign=worldwide&utm_medium=ad&utm_source=web_traffic&utm_content=&utm_term=&gclid=EAIaIQobChMIgrmvwqzU3wIVllqGCh2y1gstEAAYAyAAEgKgNPD_BwE