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AN INTRODUCTION TO ENGINEERING DISCIPLINES (ABE 206)

EDITORS:
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Dr. M. O. Sunmonu

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PREFACE

An introduction to engineering disciplines is one of the general engineering courses in both the Nigeria University Commission (NUC) and Council for Regulation of Engineering (COREN) programme Benchmark Minimum Academic Standards (BMAS). The engineering curriculum being operated at University of Ilorin is structured from 200 Level which is the first contact year of engineering to the students. Thus, engineering students of University of Ilorin actually begin their training in 200 Level for all courses. It is therefore appropriate that all the students are introduced to all disciplines being offered at university of Ilorin and the profession of engineering especially for the practice and prospects. The contents of the booklet is aimed at sensitizing the students; the would be engineers to understand the subject contents, the ethics of the professional practice and engineering career portfolio.

Seasoned and experienced lecturers from each of the engineering disciplines were assembled to offer the course. It is our belief that these students shall be motivated early enough to realize the reasons of being in the faculty and strategize how to accompany their academic aims and scholarship aspirations. The course is domesticated in the Department of Agricultural and Biosystems Engineering with course code ABE 206 and consequently coordinated by a lecturer in person of Dr. M.O. Sunmonu.

This booklet is to serve as a reading material to facilitate students learning and understanding and prepare them for the Engineer in Society course at the final stages of their training in this campus. The pictorial display of the relevant products or tools to facilitate each discipline were included as well as a chapter on the relevance of the discipline in the advancement of humanity.

Professor Y.A. Jimoh
Dean, Faculty of Engineering and Technology

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to all the Departmental Coordinators of ABE 206 (Introduction to Engineering Disciplines) for their professional contributions to this book. The Course coordinator and the Departmental Coordinators of ABE 206 wish to acknowledge with thanks the initiative of Prof. Y. A. Jimoh (Dean, Faculty of Engineering and Technology) for starting the process for the book project. Thanks go to people who participated in proof-reading, typesetting, and editing this book. The institutional cooperation and the enabling support of the University of Ilorin Administration is equally acknowledged for the sustainable enabling environment.

Dr. M.O. Sunmonu
ABE 206 Course Coordinator

NOTE ON THE FIRST EDITION

Engineers are change agents in our society. Few professions have such a direct and positive impact on people's lives. Through research and innovative solutions to real-world problems, engineers constantly re-invent the machines, processes, structures and gadgets that improve individual's daily lives. By applying science in new ways, engineers use initiative imagination to turn ideas into realities that help meet the needs of the society. During the delivery of this course-introduction to engineering disciplines, readers will learn what engineers really do and the tools they use in virtually all disciplines.

The ten programmes include agricultural and biosystems engineering (ABE), biomedical engineering (BME), chemical engineering (CHE), civil engineering (CVE), computer engineering (CPE), electrical and electronics engineering (ELE), food and bioprocess engineering (FBE), material and metallurgical engineering (MME), mechanical engineering (MEE) and water resources and environmental engineering (WRE). The lecture schedule is grouped into two main subject areas: Electrical, Mechanical, Material and Metallurgical Group (Group 1); Civil, Agricultural and Biosystems, Chemical, Biomedical and Water Resources and Environmental Group (Group 2). Group 1 contact hours is from 8 – 10 am on Mondays and holds at Agricultural Science Lecture Theatre while Group 2's contact hours is from 12 – 2.00 pm on Thursdays holding at Engineering Lecture Theatre. The grouping thus adapted is based on convenience and balancing of current population distribution.

It is a compulsory and required status for all 200 Level Engineering Students. The purpose is to allow students get a glimpse of engineering from the beginning of their study at this faculty.

The students are also informed of a discipline's scope and preparatory steps necessary for effective advancement in their training.

Dr. M.O. Sunmonu
Course coordinator

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PREFACE TO THE SUBJECT; PHILOSOPHY AND STRUCTURE, OBJECTIVES, GRADING SYSTEM AND ACADEMIC REGULATION

(i) PHILOSOPHY AND STRUCTURE OF THE COURSE

The Introduction to engineering disciplines is an emerging course that considers what engineering is, what engineers do and how their work impacts on the society. It is a course that prepares the students mind on how to become a professionally qualified engineer as well as providing the students' with fundamental engineering knowledge in their respective choice of career. Engineering is the profession aimed at modifying the natural environment; therefore the philosophy of engineering is the consideration of philosophical issues as they apply to engineering. Such issues might include the objectivity of experiments as well as the ethics of engineering activity in the workplace and in society

The general philosophy behind Engineering is that Engineers work to satisfy the needs of society (water, electricity, technological improvements etc.), and as such Engineers are expected to act ethically towards society. This course will use online resources extensively and help develop research and communication skills of students, whilst providing an overview of the historical significance of Engineers in society, and what it means to be an Engineer.

(2) OBJECTIVES OF THE COURSE

The specific objectives of this course are to:

- (i) expose the students to the various options available in their respective departments
- (ii) enlighten the students on various job opportunities available in their respective disciplines
- (iii) teach the students the theoretical and practical understanding of engineering and technology.

(3) GRADING SYSTEM

The university operates a 5-point grading system. The range of scores and the corresponding letter grades are as shown in the table below:

Grade	Grade Point	Range of Scores (%)
A	5.0	70 and above
B	4.0	60-69
C	3.0	50-59
D	2.0	40-49
E	1.0	40-44
F	0.0	Less than 40

(4) ACADEMIC REGULATION

Regulation guiding the conduct of students and staff are as stated in the University Undergraduate Academic Programme and Staff Condition of Service book respectively.

Students are to have 75% attendance before they can be allowed to sit for the examination.

ENGINEERING DISCIPLINES, OPTIONS AND GROUPINGS FOR PROGRAMME DELIVERY.

(1) DEPARTMENTAL OPTIONS

(a) Agricultural and Biosystems Engineering

- (i) Aquacultural Engineering
- (ii) Power and Machinery Engineering
- (iii) Processing and Storage Engineering
- (iv) Soil and Water Engineering
- (v) Structure and Environmental Engineering

(b) Biomedical Engineering

- (i) Biomedical Instrumentation and Micro/ Nano Systems
- (ii) Cell and Tissue Engineering
- (iii) Computational Bioengineering

(c) Chemical Engineering

- (i) Separation Processes

- (ii) Environmental Pollution Studies
- (d) Computer Engineering**
 - (i) Embedded Systems and Automation
 - (ii) Computer Communications and Networks
 - (iii) Computer System Architecture
 - (iv) Cryptography and Information Security
 - (v) Mobile Computing and Distributed Systems
 - (vi) Software Engineering
 - (vii) Computational Science Engineering
 - (viii) Computer Vision and Robotics
 - (ix) Digital Signal Processing
- (e) Civil Engineering**
 - (i) Geotechnical Engineering
 - (ii) Structural Engineering
 - (iii) Transportation Engineering
 - (iv) Water and Environmental Engineering
 - (v) Materials and Construction
- (f) Electrical and Electronics Engineering**
 - (i) Electronics and Telecommunications
 - (ii) Computer and Control Systems
 - (III) Power and Machines
- (g) Food and Bioprocess Engineering**
 - (i) Food Machine Design
 - (ii) Food Bioprocess Engineering
 - (iii) Food Storage and Packaging
- (h) Materials and Metallurgical Engineering**
 - (i) Wear and Corrosion
 - (ii) New Materials Development
 - (iii) Production Methods
 - (iv) Mineral Processing and Extractive Metallurgy
 - (v) Modelling of Metallurgical and Material Processes
- (i) Mechanical Engineering**
 - (i) Production Engineering
 - (ii) Casting and Simulation Technology

- (iii) Design
- (iv) Thermofluids
- (v) Production/Manufacturing Engineering

(j) Water Resources and Environmental Engineering

- (i) Water Resources Engineering
- (ii) Environmental Engineering

(2) COURSE GROUPINGS

The lecture time is twice a week per department so as to enable us to cater for the population of the students and to cover the syllabus for the course. This implies that the Course Instructor for each department will take the two groups in a week.

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CHAPTER 1

AGRICULTURAL AND BIOSYSTEMS ENGINEERING DISCIPLINE

C.J. Ejieji and M.O. Sunmonu

COURSE SYNOPSIS

Agricultural and Biosystems Engineering

Introduction to agricultural and biosystems engineering profession; Definition of agricultural engineering. Specializations/ Options in agricultural engineering, Use of various implements and equipment in agricultural engineering for various operations/processes .Prospects and job opportunities in agricultural and biosystems engineering as a profession; . Relevant regulatory bodies and societies in agricultural and biosystems engineering. The role of agricultural engineers in advancement of humanity.

1.0 INTRODUCTION TO AGRICULTURAL AND BIOSYSTEMS ENGINEERING DISCIPLINE

1.1 DEFINITION

Engineering – This is the profession in which knowledge of the mathematical, physical and biological sciences gained by study experience and practice is applied in the efficient use of materials and forces of nature for the benefit of man and the environment.

Agriculture – Encompasses the art, science and industry of managing the growth of plants and animals for the benefit of man. It includes the production of crops and rearing of livestock including fishes; their processing to varied degrees and products; and marketing of their end products.

Agricultural Engineering – The application of engineering and technology and the physical biological sciences in agricultural production. It requires the application of knowledge from other branches of engineering to the extent that such knowledge may be used in solving engineering problems of agriculture in all ramifications and in rural living.

The principal objective of Agricultural Engineering is to provide appropriate modern equipment, technology and conducive environment

for agricultural production, processing and storage. This ensures improved productivity, profitability and sustainability of the enterprise. Through agricultural engineering, the following are achieved:

- (a) Reduction in the hazards of farming operations
- (b) Reduction of drudgery in agricultural productions
- (c) Moderation of seasonality of agricultural produce availability by development of systems that protect production from vagaries of weather.
- (d) Continuous development and improvement of equipment and technologies for production, processing and storage
- (e) Enhancement of quality of life and financial security for farming families and enterprises.
- (f) National self-sufficiency in food supply and raw materials for agro-based industries.
- (g) Sustainability of the environment for agricultural production systems

A good agricultural engineer must be knowledgeable to an appropriate level, in most aspects of engineering disciplines and have interest in working in rural, semi-urban and peri-urban settings.

1.2 SPECIALIZATION/ OPTIONS IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING

Agricultural Engineering profession worldwide focuses its attention on six (6) main areas, namely:

1.2.1 Aquacultural Engineering

Aquaculture engineering is the branch of agricultural engineering that studies cultured aquatic species and the production systems used in their culture. Study, research and development in this area ranges from low intensity man-made pond systems to highly intensive recirculation systems involving natural lakes. Species cultured in these systems could range from warm to cold water fish and from fresh to sea water .This is an important aspect of agriculture in fishery. In modern day fishery, either in ponds, rivers, or the oceans, a variety of machines are used for raising, catching and processing fish. Aquacultural Engineering deals with the structures and machines required for various fishery operations.

1.2.2 Processing and Storage Engineering

Agricultural processing and storage is another branch of Agricultural Engineering. In this course, it will be considered in two categories, namely: Agricultural Processing and Storage of agricultural products. Agricultural processing can further be divided into crop processing and food processing. Crop processing is any procedure or treatment that prepares farm products for utilization or preservation. Food processing, however, is the process of physically or chemically converting the crops into a form that could easily be cooked or eaten. Storage can be defined as the art and science of keeping of crops in good condition in a safe place until usage time or consumption time.

1.2.3 Power and Machinery Engineering

This branch of Agricultural Engineering deals with the area of farm mechanization. Farm mechanization is defined as the application of engineering principles and technology in agricultural production, processing and storage. Agricultural mechanization is a wider term used when these activities extend beyond the boundaries of the farm unit. Farm mechanization is not only tractorization but a process of improving farming operations and farm structures. The major role of power units in the farm is to operate farm equipment for land clearing and development, cultivation, harvesting, processing, handling, transporting, loading, unloading, pumping and any other farm operations. The use of farm machinery in Nigerian agriculture is gaining popularity because of the increasing awareness to large-scale farming.

1.2.4 Structures and Environment Engineering

This branch of Agricultural Engineering deals with the planning, design and construction of farmstead and controlled environments for production, storage and processing. Farmstead structures include animal housing units, farm dwellings and produce structures. Examples of closed controlled-environment systems are silos, rumbus and green houses.

1.2.5 Soil and Water Engineering

Soil and water engineering is that branch of agricultural engineering where engineering principles are applied in solving problems associated with managing soil and water resources. The aim of soil conservation is to protect the soil from degradation which may result from the effect of water, wind and improper land use practices. Soil and water conservation may involve modified tillage and crop management practices. It could include mulching using artificial and natural materials, contouring and terracing. Conservation of soil water may also involve engineered systems for improving soil profile water storage.

Drainage is an aspect of soil and water engineering dealing with the removal of excess water from surface and subsurface of the field. Irrigation is also an aspect of soil and water engineering dealing with the application of water to the field so that crop production is not hampered by water stress. It is required when precipitation is either not available or is insufficient to meet crop water requirement.

Water conveyance systems may also consist of pipelines and canals. Field water application systems vary in levels of sophistication. They include wild flooding, engineered surface and overhead application system.

1.3 USE OF VARIOUS IMPLEMENTS AND EQUIPMENT IN AGRICULTURAL ENGINEERING FOR VARIOUS OPERATIONS

The following are some of the implements and equipment used for various operations in Agricultural Engineering:

S/No.	Operation	Implements/ Equipment
1.	seed bed or root bed preparation	primary tillage implements Like disc plough
2.	planting, fertilizer application	planter, fertilizer applicator
3.	spraying, harvesting and threshing	sprayer, combine harvester, Thresher
4.	Size reduction	hammer mill, crushers, dryers
5.	Livestock production and Processing machineries	incubators, hatchers, milk processing machines.
6.	Adding energy to water Movement in pipes	pumps
7.	Rainfall Measurement	rain gauges
8.	Water supply and Irrigation	water pumps, flow control valves and devices, sprinkler heads
9.	Crop Storage	corn cribs, rhombus, silos, Fans, conveyors. Electric motor, refrigerators, silos
10.	Bush Clearing and Land preparation	Hoes and cutlasses
11.	Power production for tillage, planting, weeding, harvesting, processing and transportation	Agricultural Tractor.
12.	Drying Operations	Solar and mechanical dryers

Other types of equipment are shown in the images below.



Weighing Scale: An instrument that measures the weight of an item



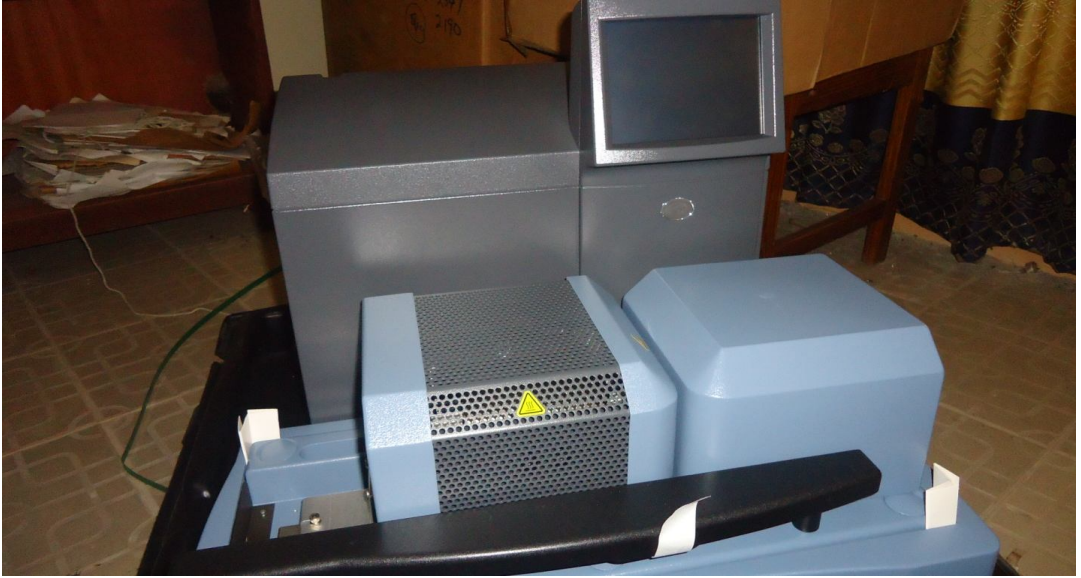
Testometric Universal Testing Machine (TUTM) : A tool for determining the mechanical properties of agricultural and biomaterials



Kartar 4000 (41") Multicrop Combine Harvester A machine that harvest grain crops.



GUNSON DIGITAL EXHAUST GAS ANALYZER (Model- G4125). An instrument for the testing and setting of all carburettors (petrol, leaded or unleaded) and petrol injection systems on any vehicle



Q600 SDT Simultaneous Differential Scanning Calorimetry and Thermogravimetry Accessories: An analysis instrument for performing both differential scanning calorimetry (dsc) and thermogravimetric analysis (tga)



WATERPROOF DIGITAL THEODOLITE TOPCON DT-207/DT. An instrument for the measurement of horizontal and vertical angles. Theodolites also determine the relative location, and are extremely useful in navigation and meteorology.



INFILTROMETERS. A device used to measure the rate of water infiltration into soil or other porous media.



WATER PUMP AND SUCTION HOSES. Instruments that lift and conduct the water from the source (lake, river, pond, etc.) to the pump.



1.4 PROSPECTS AND JOB OPPORTUNITIES IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING

The prospects of Agricultural Engineer upon completion of studies are very wide. The broad Agricultural Engineering Curriculum makes an Agricultural Engineers A “ *Jack of all trades and almost a master of all*”. So employment opportunities in Agricultural Engineering cut across many areas. Such areas are stated below.

1.4.1 Human Resources Development

To keep the Agricultural Engineering profession alive, a younger generation of Agricultural Engineers must be trained to replace the old ones. These objectives can be achieved by establishing educational and research institutions such as Universities, Polytechnics, Colleges of Agriculture and Education, Research Institutes; and by reruiting the already trained and experienced Agricultural Engineers and other relevant professionals.

1.4.2 Private Firms

An Agricultural Engineer can work in private establishments dealing with plant leasing or hiring service, consultancy services and sales and services of farm machinery.

1.4.3 Industries

Examples of industries that employ the services of Agricultural Engineers are:

- (i) Agro- industrial set up such as sugar company
- (ii) Paper production factories
- (iii) Oil palm production companies
- (iv) Vegetable oil production companies
- (v) Farm equipment manufacturing industries (design, supervision and fabrication of various farm equipment
- (vi) Feed processing industries (Agricultural Engineers advice on purchase, installation and maintenance of agro-processing equipment)

1.4.4 Private Farm Establishments

Agricultural Engineers are useful in the development of machinery maintenance procedure for private crop production farms. They can also serve in the management team of the establishment.

1.4.5 Financial Institution

The Agricultural Engineer is, in most cases, an inventory officers or investment officers in Agricultural Credit and Loan Section in institution such as banks and insurance firms.

1.4.6 Field Practice

An Agricultural Engineer may be deployed to the field to investigate the problems confronting the farmers, analyze such findings, in collaboration with other engineers and non-engineers find solutions to such problems and train farmers on how such solutions can be implemented.

1.4.7 Government Agencies Dealing with Agricultural Production

Such agencies are Ministries of Agriculture, River Basin Development Authorities, Agricultural Development Cooperation, Agricultural Mechanization Development, Boards or Cooperation or Company, World Bank Assisted Agricultural Development Programme.

1.4.8 Self Employment

An Agricultural Engineer can set up a private professional practice such as workshops that can take care of the maintenance and development of farm machinery and processing equipment.

1.4.9 Miscellaneous

An Agricultural Engineer is very versatile because of his broad background. His academic training makes him fit for some civil and mechanical jobs. He can be an Environmental Engineer, Waste Management Engineer, Quality Control Engineer and Project Engineer. He can pursue higher degrees in these other engineering branches and he can be easily trained to face series of challenges in these disciplines.

1.5 RELEVANT PROFESSIONAL BODIES IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING

A Professional Regulatory Body is a body established by a decree or an act of the legislative arm of Government and its primary function is to regulate the training of members of the profession and the professional practice. Such regulatory body for the Agricultural Engineering and other Engineering professions in Nigeria is the Council for the Regulation of Engineering in Nigeria (COREN). A practicing agricultural engineer must be registered by the Council for the Regulation of Engineering in Nigeria (COREN). A professional Society is an association formed by members of the profession with the primary objectives of providing a forum where members of the profession can interact to share ideas. Such professional societies are Nigerian Society of Engineers (NSE), Nigerian Institution of Agricultural Engineers (NIAE), West African Society of Agricultural Engineers (WASAE) and American Society of Agricultural and Biological Engineers (ASABE). The Nigerian Society of Engineers is the umbrella association for all

engineering disciplines in Nigeria and it provides a bigger forum where, apart from interacting with themselves, Agricultural Engineers can interact with other engineering professionals.

1.6 THE ROLES OF AGRICULTURAL ENGINEERS IN ADVANCEMENT OF HUMANITY

Agricultural Engineers can contribute to the development of our nation through agricultural development in the following ways:

- (i) Development and production of appropriate agricultural machinery
- (ii) Development and production of storage and processing facilities for the farm produce
- (iii) Development of appropriate Irrigation and Water Conservation methods that can be readily practiced by our farmers
- (iv) Formulation of, and research into, mechanization system that will be relevant to our vegetation and soil types
- (v) Standardization of equipment being imported into the country
- (vi) Conduction of research into human factors in the use of machinery
- (vii) Formulation of appropriate standard agricultural mechanization management systems that will be peculiar to Nigeria though may be adaptable to other countries in the areas of maintenance
- (viii) Research into fundamental problems affecting operations of the machines e.g soil dynamics
- (ix) Investigation into material properties of crops to determine the appropriate storage facilities to be provided.
- (x) Crop Production
- (xi) Animal and Fish Production
- (xii) Management, Distribution and Transportation

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CHAPTER 2

BIOMEDICAL ENGINEERING DISCIPLINE

K.A. Akande

COURSE SYNOPSIS

Biomedical Engineering

Introduction to biomedical engineering profession: Definition of biomedical engineering. Specializations/ Options in biomedical engineering. Use of various implements and equipment in biomedical engineering for various operations/processes. Prospects and job opportunities in biomedical engineering as a profession. Relevant regulatory bodies and societies in biomedical engineering. The role of biomedical engineers in advancement of humanity.

2.0 INTRODUCTION TO BIOMEDICAL ENGINEERING DISCIPLINE

2.1 DEFINITION

Biomedical engineering is an interdisciplinary field that is concerned with the use of engineering principles and medicine to biological and medical problems. It involves the application of concepts, knowledge, and approaches of almost all engineering disciplines (for examples: Electrical and Electronics, Mechanical, Civil, Chemical, Materials, and Computer Engineering) to solve specific healthcare related problems.

A biomedical engineer can be a Medical Doctor, Lawyer, Scientist, Lecturer, CEO or Director of a company. A university degree in biomedical engineering will prepare any one for any of these professions and more. Biomedical engineers work in industries, academic institutions, hospitals and government agencies. How much education does a biomedical engineer require ? A minimum of four to five years of university education is required. A Master's or Doctoral degree offers the biomedical engineer greater opportunities in research and development. Many biomedical engineers go on to attend medical or dental schools. Biomedical engineers even choose to enter law school, planning to work with patent law and intellectual property related to biomedical inventions.

2.2 SPECIALIZATION-/ OPTIONS IN BIOMEDICAL ENGINEERING

The Department of Biomedical Engineering has the following three options that are available to the 500 level students:

2.2.1 Biomedical Instrumentation and Micro/ Nano Systems

This option prepares students that are interested in the design, research and development, maintenance, repairs and safety of medical equipment used in the hospital. Also, design principles of constructing nanomaterials for use in drug delivery, diseases diagnosis and medical imaging system, food and drugs administration regulations.

2.2.2 Cell and Tissue Engineering

This option prepares students in the area of molecular biology, regenerative medicine, bioreactors, methods of analyzing tissues, stem cell culture, adult and pluripotent stem cells. Also, in the effects of chemical and electrical stimuli on cell function, gene regulation, signal transduction processes, enzyme evolution and polymeric biomaterials.

2.2.3 Computational Bioengineering

This option prepares students in the area of image processing and analysis, modeling dynamic and control system. Feedback and feed forward control systems, bioinformatics, computational model constructions for physiological, biomolecular and cellular systems.

Other key areas of Biomedical Engineering include:

2.2.4 Clinical Engineering: Clinical Engineers support and advance patients' care by applying engineering and managerial skills to healthcare technology. They can be based in hospitals, where responsibilities can include managing the hospitals' medical equipment systems for safety and effectiveness.

2.2.5 Bioinformatics: Bioinformatics is the field of science in which biology, computer science, and information technology merge to form a single discipline. The ultimate goal of the field is to enable the discovery of new biological insights as well as to create a global perspective from which unifying principles in biology can be discerned.

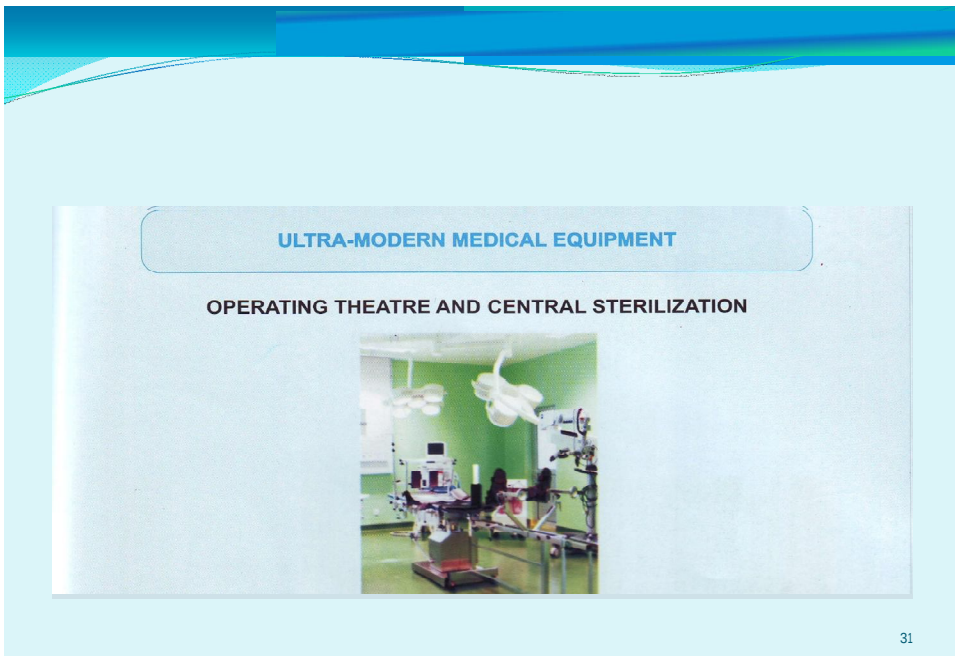
2.2.6 Bio MEMS: Bio Micro-electromechanical systems (MEMS) are the integration of mechanical elements, sensors, actuators, and electronics in the field of Biomedical and Health Sciences. It is expected to revolutionize the way medicine is practiced and delivered. For examples: development of micro-robots to perform surgery inside the body, and devices that could be implanted inside the body to deliver drugs on the body's demand.

- 2.2.7 Biomechanics:** Biomechanics is the mechanics applied to biology. This includes the study of motion, material deformation, and fluid flow. Fluid dynamics involved in blood circulation and the development of artificial hearts is a good example.
- 2.2.8 Biosignal Processing:** Biosignal processing involves extracting useful information from biological signals for diagnostics and therapeutics purposes. This could mean studying cardiac signals to determine whether or not a patient will be susceptible to sudden cardiac death, developing speech recognition systems that can cope with background noise, or detecting features of brain signals that can be used to control a computer.
- 2.2.9 Micro and Nanotechnology:** These fields include the development of microscopic force sensors that can identify changing tissue properties as a way to help surgeons remove only unhealthy tissue, e.g. using nanometer length cantilever beams that bend with cardiac protein levels in ways that can help doctors in the early and rapid diagnosis of heart attacks.
- 2.2.10 Robotics in Surgery:** Robotics in surgery includes the use of robotic and image processing systems to interactively assist a medical team both in planning and executing a surgery. These new techniques can minimize the side effects of surgery by providing smaller incisions, less trauma, and more precision, while also decreasing costs.
- 2.2.11 Nuclear medicine:** Nuclear medicine scans the detected radiation coming from a radiopharmaceutical that is inside a patient's body. In contrast, other imaging procedures (such as X-ray and CT scan) obtain images by using devices that send radiation through the body. Nuclear medicine is also different from other imaging procedures in that it determines the presence of disease based on biological changes in tissue rather than changes in anatomy. Nuclear medicine procedures are among the safest diagnostic imaging exams available; the amount of radiation received from a nuclear medicine scan is comparable to that of many diagnostic X-ray and CT procedures.
- 2.2.12 Radiology:** It refers to the use of radioactive substances such as x-ray, magnetic fields as in magnetic resonance imaging (MRI), Computed Tomography (CT) and ultrasound to create images of the body, its organs and structures. These images can be used in the diagnosis and treatment of disease, as well as to guide doctors in image-guided surgery.

2.2.13 Radiotherapy: Radiotherapy treatment of a patient requires an individual planning, which includes mainly two areas: the medical and physical treatment planning taking into account of radiobiological aspects that; all body cells can be damaged or killed by radiation, but tumor cells are more sensitive to radiation than normal cells. Radiotherapy equipment such as Digital Linear Accelerator (LINAC) uses this principle to damage beyond repair; or kills the abnormal cancer cells in a tumor. This equipment is used in successful radiation therapy to deliver a dose of radiation to the tumor while ensuring minimum radiation to the normal tissue.

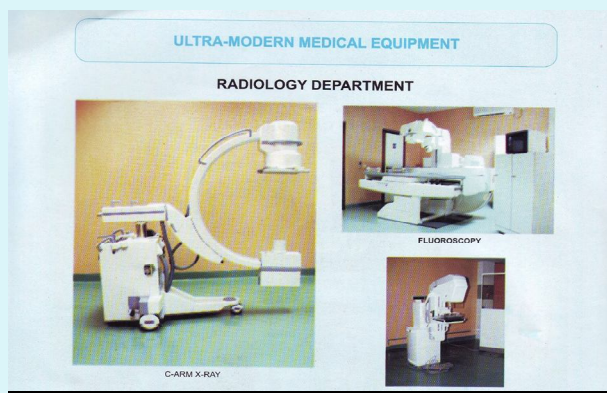
2.3 USE OF VARIOUS IMPLEMENTS AND EQUIPMENT IN BIOMEDICAL ENGINEERING FOR VARIOUS OPERATIONS

The following are some of the biomedical equipment used in hospitals:





32



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MAGNETIC RESONANCE SYSTEM



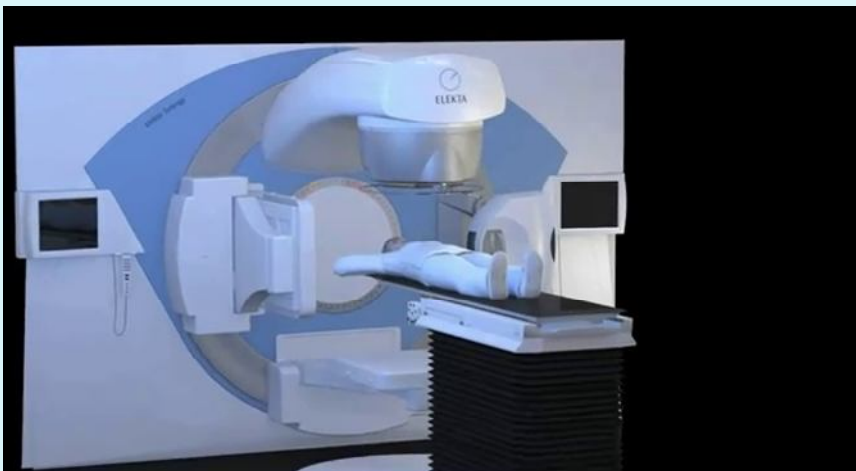
ANGIO PERIPHERY

RADIOLOGY FACILITIES

- C-ARM OEC 7700 X-RAY C-ARM 17CM 1.1, 2MON;
- INCLUDING VIDEO PRINT
- MOBILESTMX PLUS X-RAY UNIT MOBILE
- SILHOUETTE VR RADIOGRAPHY UNIT WITH BUCKY WALL STAND
- RADIO FLUORESCENT PRESTIGE FLUOROSCOPY, 90/15, 50KW
- VASCULAR ADV ANT X LCA ANGIOGRAPHY PERIPHERY
- MAMMO DMR PLUS MAMMOGRAPHY UNIT WITH BIOPSY
- MAGNETOM CONCERTO MAGNETIC RESONANCE SYSTEM- 0.2T
- MEDIPOT 903 FILM PROCESSOR AUTOMATIC
- DRL/DV -GREEN SAFELIGHT WALL MTD WITH FILTERS
- ID/DR ID CAMERA X-RAY FILM ID CAMERA
- W62 X-RAY FILM STORAGE CABINET
- VARIOUS SET OF CASSETTES WITH SCREENS
- CASSETTE GRIDDED WITH AMPLIFIER SCREEN
- WM 90/43 ILLUMINATOR X-RAY DOUBLE
- LEAD APRONS MINI
- LEAD APRON, SINGLE SIDED
- MWT -V21/HFV MAMMO FILM VIEWER, HIGH LIGHT DENSITY

35

DIGITAL LINEAR ACCELERATOR (LINAC) BY ELEKTA



28

Digital Linear Accelerator: A device used for external beam radiation treatment for patient with cancer.

2.4 PROSPECTS AND JOB OPPORTUNITIES IN BIOMEDICAL ENGINEERING

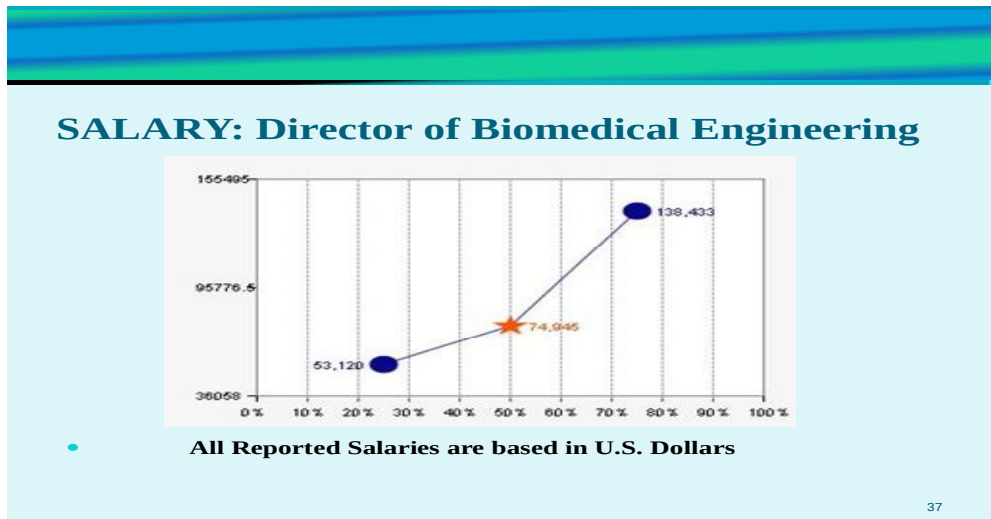
The work of traditional biomedical engineers actually did not require much knowledge of biology. Due to many of the reasons listed and others, for a long time, biology was not amenable to engineering analysis and synthesis design approach.

Some examples of areas where engineers rely on the design and implementation skills learned in their own disciplines to solve problems in biology are as explained. Until recently, the development of imaging techniques to diagnose a particular medical condition relied mostly on physics. The design of replacement body structures, the fabrication and fitting of artificial limbs, and the creation of devices used for repairing and or replacing these body parts were founded on knowledge of mechanics and material sciences. The processing and delivery of pharmaceuticals into biological systems were based on chemistry.

The prospects and job opportunities for biomedical engineers are much better than other engineers in other engineering fields.

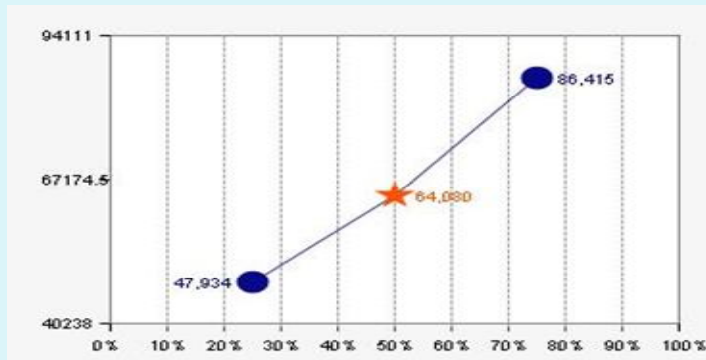
According to a documentary in 2014 by the *CNN Money* lists Biomedical Engineering as the **#1 best job** in America, stating that, *"Not only is it one of the **highest-paid** engineering jobs, it's a career that gives back to society by helping to **improve world health.**"*

The average salary per year of some of the biomedical engineering jobs in USA are shown below:



The average salary of Director of Biomedical Engineering Department in US is \$74,945 per year.

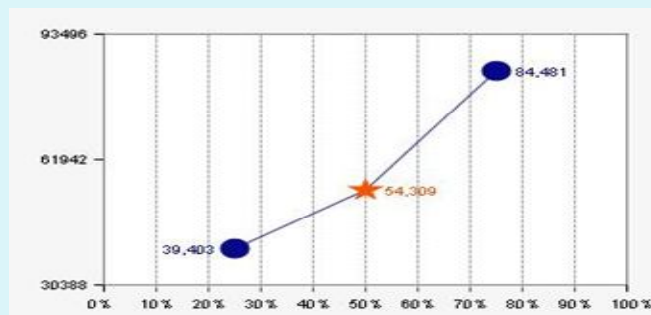
SALARY (\$): Biomedical Engineer



39

The average salary of a Biomedical Engineer in USA is \$64, 080 per year.

SALARY (\$): Supervisor Clinical Engineering



40

The average salary of a Supervisor Clinical Engineer in USA is \$54, 309 per year.

2.5 RELEVANT PROFESSIONAL BODIES IN BIOMEDICAL ENGINEERING

The relevant regulatory bodies and societies in Nigeria for biomedical engineers are listed below:

1. Nigerian Society of Engineers (NSE)
2. Council for the Regulation of Engineering in Nigeria (COREN)
3. Association of Medical Devices Engineers (AMDE)
4. Nigerian Institute for Biomedical Engineering (NIBE)

2.6 THE ROLE OF BIOMEDICAL ENGINEERS IN ADVANCEMENT OF HUMANITY

The genomic and molecular revolutions in biology, commonly identified by the Human Genome Project, has allowed us to identify all 26,000 genes in the human body and to determine many of their individual sequences. Our sequencing of amino acids in proteins and of bases in nucleic acids spurred the development of bioinformatics, which relies on the use of computers to analyze the sequences for patterns and similarities.

These advances in the understanding of biology added much knowledge to our toolkit and spurred the growing interface between biology and engineering. For the first time, one can look at biology from a different perspective and with a much greater attention to detail. The operation of biological functions can now be understood as complex “biomolecular machines.” The regulation of biological functions can be seen as complex “biomolecular circuits.”

The following show a few of the many areas today that solicit the knowledge and practical skills of bio-engineers:

- (i) In the past, only mechanical aspects such as flexibility, durability, and endurance to changes in outside conditions were considered in the design of spacesuits. Now, bioengineers incorporate knowledge of the physiology of the human body into the finalization of their designs.
- (ii) The design and implantation of hip implants was previously solely a branch of mechanical engineering. The mechanics and movements of the hip were studied to produce the best metal substitute. Today, greater emphasis is placed on the understanding of bone composition and tissue-implant suitability and biomaterials.
- (iii) MRI produces images of the body regardless of intervening bone by means of a strong magnetic field and low-energy radio waves.

- (iv) Controlled-release drug delivery relies on knowledge of the body's enzymes and whether certain polymers or drugs would be degraded by them.
- (v) Image-guided surgery records surgical processes with greater detail and allows doctors to consult past steps for comparison and completeness.
- (vi) The quest for an ideal replacement artificial heart continues to baffle the scientific community. In the past, engineers devoted their efforts to designs based on non-biological materials. They were met with repeated failure as the complex biological systems of the body formed blood clots to signal rejection of foreign substances such as metal, plastic, and polyester. Today, biological engineers are exploring ways to design hearts out of biomaterials and possibly other tissues.

Biomedical Engineering is indeed an interdisciplinary field, a career that is relatively new and highly needed in Nigeria. The few Biomedical Engineering Diploma programs established at Lagos Teaching Hospital (LUTH), Ahmadu Bello University Teaching Hospital (ABUTH), University of Maiduguri Teaching Hospital (UMTH), University of Benin Teaching Hospital (UBTH), and degree programs at Federal University of Technology, Owerri (FUTO), Federal University of Technology, Akure (FUTA), BELL University and the engineering degree program now at UNILORIN are not enough to produce the great numbers of Biomedical Engineers, Technologists and Technicians that are needed for the repairs, maintenance and application of the high-tech biomedical equipment in Nigeria's hospitals; not to talk of ***research in different areas of biomedical engineering, design and fabrication of medical devices.***

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CHAPTER 3

CHEMICAL ENGINEERING DISCIPLINE

O.A.A. Eletta

COURSE SYNOPSIS

Introduction to chemical engineering profession: Definition of chemical engineering. Specializations/ Options in chemical engineering. Use of various implements and equipment in chemical engineering for various operations/processes. Prospects and job opportunities in chemical engineering as a profession. Relevant regulatory bodies and societies in chemical. The role of chemical engineers in advancement of humanity.

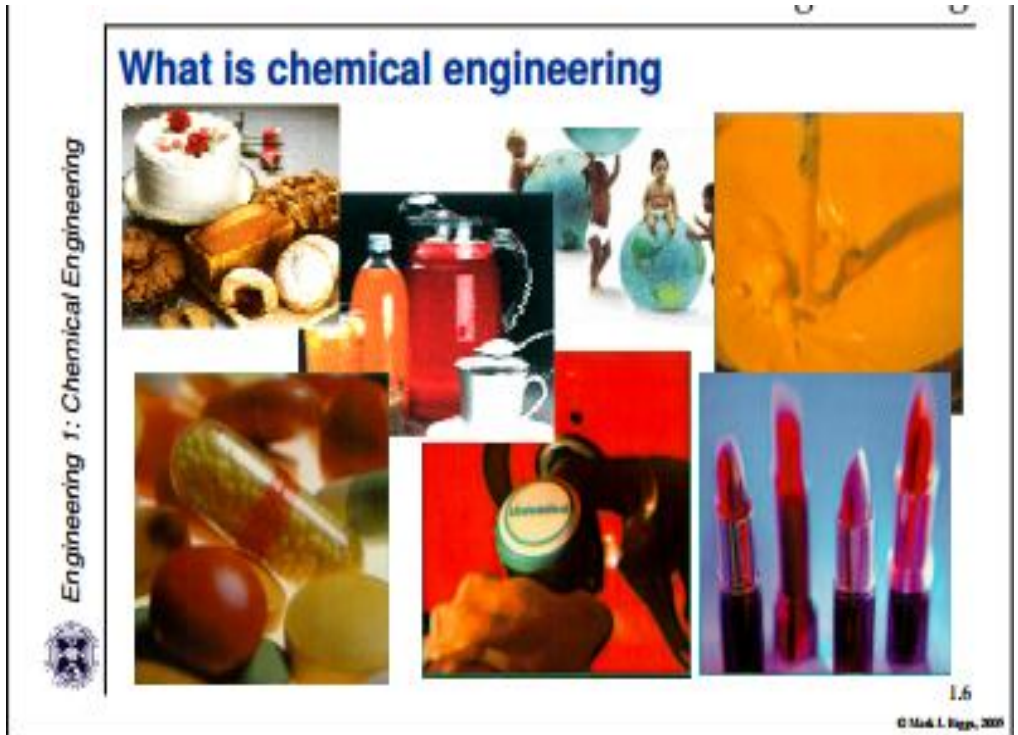
3.0 INTRODUCTION TO CHEMICAL ENGINEERING DISCIPLINE

3.1 DEFINITION

What is Chemical Engineering?

There is no universally accepted definition; it can be defined as,

- that branch of Engineering that is aimed at the design of processes involved in **conversion of raw materials from one form to another** more useful (and so more valuable) form, economically, safely and in such a way that the environment is not comprised.
- It can also be defined as, that branch of Engineering that applies basic sciences (math, chemistry, physics & biology) and engineering principles to the development, design, operation and maintenance of processes to **convert raw materials to useful products (involving physical/ chemical changes) while ensuring that the environment is not compromised.** It involves specifying equipment, operating conditions, instrumentation and process control for all these changes.
- it can also be defined as that branch of engineering which deals with the application of the principles of physical sciences, economics and human relations to fields that pertain directly to processes and equipment where there is a change from a raw to a finished state.



Products from chemical engineering

3.2 SPECIALIZATION / OPTIONS IN CHEMICAL ENGINEERING

Some of the main areas of Chemical Engineering include:

3.2.1 Petroleum Engineering

It is a field of engineering concerned with the activities related to the production of hydrocarbons, which can be either crude **oil** or natural gas. This field is very well patronized by students of Chemical Engineering because of the lucrative nature of the sector .



Production of Hydrocarbon

3.2.2 Biotechnology

This involves the use of living systems and organisms to develop or make useful products, or to modify products or processes for specific use. It involves the application of molecular and cellular processes to solve problems, conduct research and create goods and services.

3.2.3 Environmental Engineering

This focuses on the assessment, management and design of sustainable environmental systems for the protection of man and ecological health. Systems designed include such as those used to treat and properly dispose waste, control water pollution etc.

3.2.4 Biochemical Engineering

This is a branch of chemical **engineering** deals with the design and construction of unit processes that involve biological organisms or molecules, such as bioreactors.



Bioreactor: used to treat mechanically separated organic residue among other uses

3.2.5 Process Control and Modelling

This area employs the use of softwares to design, monitor and control processes. Control involves the purposeful influence on a controlled object (process) that ensures the fulfillment of the required objectives in order to satisfy the safety and optimal operation of the technology and to meet product specifications and mathematical models of processes. These models can be constructed from a physical and chemical nature of processes or can be abstract. The investigation of dynamical properties of processes as well as whole control systems give rise to a need to look for effective means of differential and difference equation solutions. Other areas include Biomedical Engineering, Nanotechnology, Chemical Reaction Engineering, Polymer Engineering, Plastics Engineering, Food Processing, Composite Materials, Corrosion and Protective Coatings, Pharmaceuticals, Manufacture of Microelectronic Components and Transport Phenomena.

The traditional fields of chemical engineering include petrochemicals, petroleum and natural gas processing, plastics and polymers, pulp and paper, instrumentation and process control, energy conversion and utilization and environmental control.

3.3 USE OF VARIOUS EQUIPMENT IN CHEMICAL ENGINEERING FOR VARIOUS OPERATIONS AND PROCESSES

Unit Processes: "unit process" is one or more grouped operation in a manufacturing system that can be defined and separated from others. Chemical reaction engineering, chemical kinetics and chemical process modeling.

Chemical Process is a method used in manufacturing to change the composition of materials technology to a desired product. They can be illustrated as block flow diagrams which show each unit as blocks and the streams flowing between them as connecting lines with arrow heads to show direction of flow

Unit Operations: unit operation is a basic step in a process. It involves a physical change or chemical transformation. They include: separation, crystallization and evaporation. A process may require many unit operations to obtain the desired product from the raw materials. Chemical Engineering employs several unit operations. Unit operations of Chemical Engineering involve a coordinated series of separate operations. Examples of unit operations include extraction, evaporation, leaching and filtration.

The following are some of the equipment used for various operations in Chemical Engineering:

S/No.	Operation	Equipment
1	Fractional distillation	Distillation Column
2.	Drilling	Rig
3.	Food Processing	Mixers/Evaporators
4.	Soap Making	Batch Reactors
5.	Stripping	Absorption Towers
6.	Cooling	Cooling Towers
7.	Dehumidification	Dryers
8.	Heat Exchange	Heat exchangers
9.	Sedimentation	Clarifiers
10.	Design and process Modeling	Computers
11.	Freeze drying	Freeze dryers

Other heat exchange equipment include the following:

- Jacketted Vessel: the contents of a vessel are heated or cooled by condensing steam in a jacke surrounding the vessel.
- Double Pipe Heat Exchanger: consists of 2 concentric tubes with a fluid flowing in the central pipe and another flowing in the annular space either co or counter currently.S
- Shell and Tube Heat Exchangers: this is employed when the heat transfer surface required is large.

Images of other equipment used in chemical engineering units are shown below:



Crude fractionating column: Used for the separation of crude into various fractions



Liq – liq extractor: the purification of heat sensitive materials



Gas absorption column: hydrogenation of oils



Sedimentation tank: Used in waste water treatment

3.4 PROSPECTS AND JOB OPPORTUNITIES IN CHEMICAL ENGINEERING

There are quite a number of places a Chemical Engineer can be employed. The majority of Chemical Engineers work in businesses known collectively as the Chemical Process Industries (CPI). Chemical Engineers have been referred to as **“Universal Engineers.”** Chemical Engineering finds its application in the solution of the essential needs of mankind some of which includes:

3.4.1 Energy and Fuel: The petroleum and petrochemicals industry are involved in the production of petroleum products as well as nuclear and synthetic fuels. The Chemical Engineer are involved in diverse ways in this industry; they are involved in developing alternative energy sources, production, environmental monitoring, research and development and process safety. In the Petroleum Industry, a variety of opportunities abound for the Chemical Engineer in this industry. This ranges from plant design, to production of various products from crude (fuel, lubricants, liquefied Petroleum gas (LPG), Liquefied Natural Gas (LNG), petrochemicals, waxes etc)

3.4.2 Food and Beverage : Chemical engineers in the food and beverages industry, design process units for food production and packaging . They are also involved in quality control and process safety.



3.4.3 Environment, Safety and Health: Chemical engineers are employed to design processes that would reduce waste generation to the barest minimum in every process by introducing recycle streams, reusing supposed wastes. Treatment and disposal of final waste is also carried out putting in mind process safety and loss prevention.

3.4.4 Electronics: Chemical Engineers are employed in the electronics industry to handle development and production and process control equipment. They are also involved in the manufacturing of micro chips and intricate circuitry by developing materials and processes that allow such circuits to be properly assembled.



3.4.5 Design and Construction: Chemical Engineers are involved with process design and project management. They work closely with other Engineers (Electrical and Mechanical)



Process Design- Duty of Chemical Engineers

3.4.6 Business, Finance and Insurance: Chemical engineers are employed to manage, analyze, and insure businesses in the chemical process industries. They carry out process design and act as consultants to finance houses.

3.4.7 Education: Teaching, research and development is carried out by chemical Engineers to advance knowledge in the discipline

3.4.8 Consultants and Government Agencies: Many Chemical Engineers also work in supplier, consulting and governmental agencies related to the Chemical Process Industries by engaging in equipment manufacture, plant design, consulting, analytical services and standards development.

3.4.9 Industry: Chemical Engineers hold lead positions in industrial firms and governmental agencies concerned with environmental protection since environmental problems are usually complex and require a thorough knowledge of the Social Sciences, Physics, Biology, Mathematics and Chemistry for their resolution.

The majority of Chemical Engineers work in businesses known collectively as the Chemical Process Industries (CPI) such as pulp and paper, rubber and plastics, metal and mineral processing, textile, oil and gas, cosmetics/pharmaceuticals and agricultural chemicals industries.

3.5 RELEVANT PROFESSIONAL BODIES IN CHEMICAL ENGINEERING

A Professional Regulatory Body is a body established by a decree or an act of the legislative arm of Government and its primary function is to regulate the training of members of the profession and the professional practice. Such regulatory body

for the Chemical Engineering and other Engineering professions in Nigeria is the Council for the Regulation of Engineering in Nigeria (COREN). A practicing Chemical Engineer must be registered by the Council for the Regulation of Engineering in Nigeria (COREN). Other professional societies are Nigerian Society of Engineers (NSE); which is an umbrella association for all Engineering disciplines and the Association of Professional Women Engineers (APWEN). The Nigerian Society of Chemical Engineers is the recognized society under which all Chemical Engineers in Nigeria interact and collaborates. Its equivalent in the UK is The Institution of Chemical Engineers (IChemE) and in the US we have the American Institution of Chemical Engineers (A IChE).

3.6 THE ROLE OF CHEMICAL ENGINEERS IN ADVANCEMENT OF HUMANITY

Chemical Engineers can contribute to the development of our nation through chemical process development in the following ways:

- (i) Design of industrial processes : the design of the various units that make up a process is carried out by the chemical engineer.
- (ii) Development and installation of corrosion kits to protect corrosive industrial fluids from eroding units and leading to failure.
- (iii) Development of appropriate standards for processes
- (iv) Research and development to improve existing processes: Constant upgrade to ensure better, yielding processes.
- (v) Development of processes to reduce waste generation in process industries:
Waste treatment and proper disposal: Every chemical process in addition to product formulation generates wastes which could be in the 3 states of matter. The chemical engineers could be involved essentially in the treatment and disposal
- (vi) Quality control in process industries
- (vii) Feasibility studies to guide finance houses in granting facilities: It is only after going through a design and ascertaining the workability and economics that a chemical engineer would go ahead and approve a loan grant to establish
- (viii) Production .of cosmetics: Hair and body cream, make up, toothpaste etc are produce by chemical Engineers and they are used to enhance quality of skin and beauty
- (ix) Development and production of appropriate agro chemicals to improve yield in food.

- (x) Production of textile and synthetic shelter material : Clothing and housing: new and better materials such as synthetic fibers, plastics and polymers, plywood and hardboards are used in place of the rapidly decreasing natural resources.
- (xi) Health: the chemical engineers have a lot of noteworthy contribution to health and population control in the industrial production of drugs and pharmaceuticals. The chemical engineer study complex chemical processes and materials to improve the quality of life through the creation of medical devices such as prostheses and biomaterials. Examples are artificial organs, contact lenses, artificial hips etc they are also involved in the chemical synthesis of and prolong life sustaining aids like the heart – lung machine , synthesis of drugs, genetic engineering and gene therapy.
- (xii) Food : they are involved with increasing the production and processing of food; in the production of fertilizers, insecticides and herbicides.
- (xiii) Clothing and housing: new and better materials such as synthetic fibers, plastics and polymers, plywood and hardboards are used in place of the rapidly decreasing natural resources.

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CHAPTER 4

CIVIL ENGINEERING DISCIPLINE

Y.A. Abdulkareem., A.R Anwar, and A.W.Salami

COURSE SYNOPSIS

Civil Engineering

Introduction to civil engineering profession: Definition of civil engineering. Specializations/ Options in civil engineering. Use of various implements and equipment in civil engineering for various operations/ processes Prospects and job opportunities in civil engineering as a profession. Relevant regulatory bodies and societies in civil engineering. The role of civil engineers in advancement of humanity.

4.0 INTRODUCTION TO CIVIL ENGINEERING DISCIPLINE

4.1 DEFINITION

Civil Engineering – The professional engineering discipline in which a knowledge of mathematical and physical sciences is applied in planning, designing, construction and maintenance of physically and naturally built environment like roads, airports, seaports, bridges, towers, buildings, dams, canals, water supply, waste water treatment etc within the context of safety, economy, efficiency, reliability and environmental viability with the aim of improving the well being of humanity.

Civil Engineering is the second oldest engineering discipline after military engineering. Civil Engineering may be regarded as the profession that makes the world a more agreeable place in which to live.

4.2 SPECIALIZATIONS / OPTIONS IN CIVIL ENGINEERING

Civil Engineering being a very broad discipline that keeps expanding and accommodating new areas of research and application necessitates the need for division into several areas of specialization such as Structural, Material, Geotechnical, Transportation, Construction Management, Water Resources and Environmental Engineering.

4.2.1 Structural Engineering

This is concerned with the planning, designing, construction and maintenance of structural buildings such as bridges, towers, flyovers (overpasses), tunnels, off shore structures like oil and gas fields in the sea, buildings (sky scrapers, apartments, offices, hospitals, shops etc) and other structures. This involves identifying the external loads which act upon a structure and the forces and stresses which arise within that structure due to those loads, and then designing the structure to successfully support and resist those loads. The loads can be self weight of the structures, other dead load, live loads, moving (wheel) load, wind load, earthquake load, load from temperature change etc. The structural engineer must design structures to be safe and economical for their users and to successfully fulfil the intended purpose they are designed for (to be *serviceable*). Structural Engineer is expected to consider the followings: safety, cost, constructability, aesthetics and sustainability.

4.2.2 Materials and Construction Engineering

Material Engineering deals with the design and development of new or improved materials either for construction of engineering facilities such as buildings, dams, roads, tunnels, sewers, railways etc or for repair of existing damaged structures. Materials Engineers cut across all sub disciplines of civil engineering. Most of the modern structures such as Burj Arab in Dubai, Taipei 101 in Taipei, Shanghai World Financial Centre in Shanghai, International Commerce Centre in Hong Kong, Willis Tower in Chicago, Empire Building in New York, have come to existence with the help of materials engineers.

4.2.3 Geotechnical Engineering

Geotechnical Engineering is a sub discipline of Civil Engineering that focuses on soils, rocks and water in relation to design, construction, Operation and maintenance of Building and Civil Engineering facilities. The services of Geotechnical Engineers are very vital in the field of Civil Engineering as all the structures are built on soil or with soil. Geotechnical Engineer employs the knowledge of geology, hydraulics, mechanics, mathematics, materials science and testing to safely and economically design foundations, retaining walls etc. Geotechnical Engineer also addresses environmentally related problems within the domain of underground water and waste disposal.

4.2.4 Transportation Engineering

Transportation Engineering deals with the moving people and goods efficiently, safely, and in a manner conducive to a vibrant community. It involves planning, design, construction, operation and maintenance of the infrastructure associated with vehicles, driver/passengers and right of ways. The role of transportation engineer includes: planning and design of highways roads and streets, the design and construction of railway tracks, air ports and harbours, traffic safety and traffic management. Schemes including appraisal of investments in transportation related programmes.

4.2.5 Construction Management Engineering

Construction management involves planning, design, estimating, scheduling, cost plan, control, and resource management of whole projects. Construction management engineer is tasked with the responsibilities of coordinating the whole project so as to achieve satisfactory execution of the project within the context of managing all resources such as personnel, material, time and money.

4.2.6 Water Resources Engineering

Water resources engineering is concerned with the planning and management of water as a natural resource. It combines hydrology, environmental science, meteorology, geology, conservation and resource management. This area of civil engineering relates to the prediction and management of both the quality and quantity of water in both underground (aquifers) and above ground (lakes, rivers and streams) resources. Water resource engineers analyze and model very small to very large areas of the earth to predict the amount and content of water as it flows into, through or out of a facility. Hydrologic engineering deals with the flow and conveyance of water. This aspect of water resources engineering is intimately related to the analysis and design of pipelines, water supply network, drainage facilities (dams, channels, culverts, levees, storm sewers) and canals.

4.2.7 Environmental Engineering

Environmental engineering deals with gathering of information on the environmental consequences of proposed actions and assessment of the effects of proposed actions for the purpose of assisting society and policy makers in making decisions. Environmental engineering also deals with the treatment of chemical, biological, and/or thermal waste, the purification of water and air, and the remediation of contaminated sites, due to prior waste disposal or accidental contamination. Such issues as pollutant transport, water purification, waste water

treatment, air pollution, solid waste treatment, waste recycle and hazardous waste management are all addressed by environmental engineers.

4.3 USE OF VARIOUS IMPLEMENTS AND EQUIPMENTS IN CIVIL ENGINEERING FOR VARIOUS OPERATIONS

Some of the implements and equipment used for various operations in civil engineering are presented below:

*A **grader** is a construction machine with a long blade used to create a flat surface during the grading process. In civil engineering, the grader's purpose is to "finish grade" (to refine or set precisely) the "rough grading" performed by heavy equipment or engineering vehicles such as scrapers and bulldozers.

Graders are commonly used in the construction and maintenance of dirt roads and gravel roads. In the construction of paved roads they are used to prepare the base course to create a wide flat surface for the asphalt to be placed on. Graders are also used to set native soil foundation pads to finish grade prior to the construction of large buildings. Graders can produce inclined surfaces, to give cant (camber) to roads. In some countries they are used to produce drainage ditches with shallow V-shaped cross-sections on either side of highways.





GRADER

*A **bulldozer** is a crawler (continuous tracked tractor) equipped with a substantial metal plate (known as a blade used to push large quantities of soil, sand, rubble, or other such material during construction or conversion work and typically equipped at the rear with a claw-like device (known as a ripper) to loosen densely compacted materials.





BULLDOZER

*An **excavator** is the machine that can excavate the soil of various types forcefully and then using hydraulic system a hydraulic force is generated and utilizing this force, a bucket is pulled back towards the machine. Bucket of excavator is replaceable. If front bucket is exchanged with some other attachments then an excavator can be used for multi-purpose. For example: pile diver, hydraulic jack hammer etc. Excavator is used for digging of trenches, holes, foundations, material handling, brush cutting with hydraulic attachments, forestry work, forestry mulching, demolition, general grading/landscaping, mining, especially, but not only open-pit mining, river dredging, driving piles, in conjunction with a pile driver and drilling shafts for footings and rock blasting.



EXCAVATOR

*A **loader** (bucket loader, front loader, front-end loader, payloader, scoop, shovel, skip loader, or wheel loader) is a heavy equipment machine used in construction and sidewalk maintenance to move aside or load materials such as asphalt, demolition debris, dirt, snow, feed, gravel, logs, raw minerals, recycled material, rock, sand, woodchips, etc. into or onto another type of machinery (such as a dump truck, conveyor belt, feed-hopper, or railroad car). Loaders are used mainly for loading materials into trucks, laying pipe, clearing rubble, and digging. A loader is not the most efficient machine for digging as it cannot dig very deep below the level of its wheels, like a backhoe can.



LOADER

*A **road roller** (sometimes called a *roller-compactor*, or just *roller*) is a compactor type engineering vehicle used to compact soil, gravel, concrete, or asphalt in the construction of roads and foundations, similar rollers are used also at landfills or in agriculture.



ROLLER

*A **concrete mixer** (also commonly called a **cement mixer**) is a device that homogeneously combines cement, aggregate such as sand or gravel, and water to form concrete. A typical concrete mixer uses a revolving drum to mix the components. For smaller volume works portable concrete mixers are often used so that the concrete can be made at the construction site, giving the workers ample time to use the concrete before it hardens.



CONCRETE MIXER

4.4 PROSPECTS AND JOB OPPORTUNITIES IN CIVIL ENGINEERING

The dynamic and diverse nature of civil engineering gave it a very high prospect throughout the globe. Civil engineering practice has been common in any type of economy, be it developed, developing or underdeveloped as it has direct relationship with nearly all aspects of life. Any society needs treated water and supply of the water to needy areas, improved irrigation system for food security, shelter, hospitals, reliable transportation system, power generation facilities like dams and power plant, environmental protection and management. Our future as a nation will be closely tied to space, energy, the environment, and our ability to interact with and compete in the global economy. As the technology revolution expands, as the world's population increases, and as environmental concerns mount, civil engineering skills will be needed more and more.

Civil engineers have numerous opportunities to be employed in various places such as:

4.4.1 Government Establishments

Civil Engineers can work in works department of all the ministries and parastatals. They have greater opportunities in Civil Engineering related Ministries and parastatals such as ministry of works and ministry housing, ministry water resources, ministry land and survey, ministry environment, ministry Agriculture, Port Authority, Nigerian maritime, Water board, Abuja environmental protection agency, Federal Road Maintenance Agency (FERMA), Federal Capital Development Authority (FCDA), River basin development authorities, Road safety, pavement evaluation unit (PCU) etc.

4.4.2 International Agencies/Non-Governmental Organizations

Civil engineers are blessed with opportunity to work with International agencies and Non-governmental organizations like World Health Organization (WHO), Japanese International Corporation Agency (JICA) and United Nations Development Programme (*UNDP*).

4.4.3 Academia/ Research Institutes

The services of civil engineers can be employed by Universities, Polytechnics and Colleges where he will be involved in educating students in technical specialties, inculcates engineering ethics and standards of safety and engages in research and scholarly endeavours.

4.4.4 Private Companies

Privates companies are the major employers of Civil Engineers. Some of the companies that employ civil engineers are Construction Companies, Consultancy firms, Oil and gas industries, Chemical companies (helping to reduce waste in streams), Pharmaceutical companies (producing drugs that are environmentally safe), Pulp and paper mills (reducing wastes and restoring forests), Nuclear plants (helping in safe disposal of nuclear wastes), Companies that develop and sell building materials such as cement companies, metal producing companies ceramics companies etc, Companies that develop and sell construction materials such as ready –mix concrete producers and pavement companies.

4.5 RELEVANT PROFESSIONAL BODIES IN CIVIL ENGINEERING

In Nigeria, Council for the Regulation of Engineering in Nigeria (**COREN**) is a statutory organ of the Federal Government established by Decree No.55 of 1970, as amended by Decree 27 of 1992, which empowers it to control and regulate the practice of the engineering profession in all aspects and ramifications in the country.

The Nigerian Society of Engineers (**NSE**) is a voluntary association established by the practitioners of the profession in 1958 with the primary objective of providing a rallying forum for Nigerian Engineers to address the problem of colonial marginalisation for an increased participation in the policy formulation and physical development of our fatherland.

Nigerian Institution of Civil Engineers (**NICE**) is a division of Nigerian Society of Engineers (NSE) established in 1984 by the council of NSE with the aim of bringing civil engineering practitioners together in order to promote civil engineers professional welfare in the country. It has now emerged to be the leading division in Nigerian society of engineers.

Nigerian Geotechnical Association (**NGA**) is also a division of Society of Engineers (NSE) established to create a communication platform for professionals, researchers and policy makers with aim of standardising the practice of geotechnical engineering in Nigeria for sustainable infrastructural development

International Society for Soil Mechanics and Geotechnical Engineering (**ISSMGE**) is the pre-eminent professional body representing the interests and activities of Engineers, Academics and Contractors all over the world that actively participate in geotechnical engineering.

The **American Society of Civil Engineers (ASCE)** is a tax-exempt professional body founded in 1852 to represent members of the civil engineering profession worldwide. Its mission is to "provide essential value to our members and partners, advance civil engineering, and serve the public good". ASCE strives to "facilitate the advancement of technology", "encourage and provide the tools for lifelong learning", promote professionalism, influence public policy, "develop and support civil engineer leaders", and "advocate infrastructure and environmental stewardship

Many more international professional bodies related to civil engineering are based in different parts of the world such as Canadian Society for Civil Engineering, Institute of Transportation Engineers, British Institute of Non-Destructive Testing, Chartered Institution of Highways and Transportation, Nigeria Institute of Highway Engineers, Institute of Healthcare Engineering and Estate Management, Institute of Marine Engineering, Science and Technology, Institute of Materials, Minerals and Mining, Institution of Civil Engineers, Institution of Railway Signal Engineers and Institution of Structural Engineers.

4.6 THE ROLE OF CIVIL ENGINEERS TO HUMANITY

The contributions of civil engineers in advancement of humanity have been very tremendous, some of which are presented below:

- (i) The collection, storage, treatment, transmission and distribution of water played a significant role in urbanization, population growth and commercial agriculture and land use.
- (ii) Provision of safe drinking water, cleaning up sites contaminated with hazardous materials, cleaning up and preventing air pollution and managing solid wastes.
- (iii) Boosting economy through provision of safe, economic, efficient and environmentally viable means of transporting persons and goods from one place to another by provision of road networks, bridges, traffic safety measures, traffic control facilities, railways, harbours, docks etc
- (iv) Enhancing food security by facilitating irrigational activities through construction of dams, canals, channels and the preparation of the irrigation land to the required gradient
- (v) Provision of safe, economical and environmental friendly structures such as Stadiums, arenas, skyscrapers, offshore oil structures, space platforms, amusement park rides, bridges, office buildings, residential buildings etc
- (vi) Addressing the problems of rapid urbanization including increasing population and land cost by bringing into existence sky scrapers which makes it possible for towns nowadays to have freedom of developing vertically.
- (vii) Developing new materials, upgrading existing materials and renewal of waste materials for construction purposes
- (viii) Provision of sustainable energy through construction of hydraulic structures for hydropower projects and construction of towers for wind turbines

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CHAPTER 5

COMPUTER ENGINEERING DISCIPLINE

J.F. Opadiji and S.A. Olatunji

COURSE SYNOPSIS

Computer Engineering

Introduction to computer engineering profession: Definition of computer engineering. Specializations/ Options in computer engineering. Use of various implements and equipment in computer engineering for various operations/ processes. Prospects and job opportunities in computer engineering as a profession. Relevant regulatory bodies and societies in computer engineering. The role of computer engineers in advancement of humanity.

5.0 INTRODUCTION TO COMPUTER ENGINEERING DISCIPLINE

5.1 DEFINITION

Computer Engineering is a discipline that incorporates several aspects of electrical and electronics engineering with computer science in order to develop computer-based systems. This field of engineering seeks to enhance the capability and applicability of computers in every facet of human endeavor and modern life. It entails the development of improved computer hardware and software systems and how they can be integrated into other machines, materials, devices and systems to accomplish more and perform better. It also involves the building of networks for computer communication, human-computer interaction and transfer of data. Several techniques are constantly being developed to improve computer systems by making them faster, smarter, more mobile and adaptable to solve various computer-oriented problems.

Computer Engineers usually have training in electrical and electronic engineering, computer science and hardware-software integration for different applications, such as the design of microprocessors and VLSI chips, writing of software and firmware for embedded systems, designing of sensors, mixed signal circuit boards, operating systems for personal and supercomputers. Robotics and computer vision are also included as areas of applications where digital systems are employed to control and monitor electrical systems, while taking strategic decisions dynamically and autonomously.

5.2 SPECIALIZATIONS / OPTIONS IN COMPUTER ENGINEERING

5.2.1 Embedded Systems and Automation

Embedded systems are specialized computer systems designed to carry out specific functions in a larger electrical or mechanical system. Embedded systems are found in many devices from cell phones to unmanned spacecrafts. The study of these systems constitutes an area of specialization in computer engineering which applies the knowledge of electronics, artificial intelligence, instrumentation and control to automate home appliances, office equipment, automobiles as well as small and large scale industrial machines. Computer Engineers in this area design computer systems which enhance the speed, reliability, and performance of larger systems.

5.2.2 Computer Communications and Networks

This area of specialty aims to advance technology from the frontiers of data communication, computer networking, telecommunications systems and networks (both wired and wireless networks), modulation, information theory, error-control coding and correction. Research is constantly on-going to explore new frequency bands, frequency re-use, and dynamic spectrum usage and to increase the efficiency of communication channels. Computer Engineers in this area of help to design and analyze high-speed network, fault-tolerant systems, storage and transmission schemes while improving modulation techniques and interference suppression methods.

5.2.3 Computer Systems Architecture

Computer Engineers in this specialty work and research into techniques to develop reliable, secure, testable and high-performance computer systems. Projects worked on include the design of more efficient processors and coprocessors for multi-threading and parallel processing, enhancing the energy efficiency of VLSI circuits, simulating discharge protection for CMOS circuits, improving computer storage, development of new theories and algorithms on how to build highly-reliable and secure computer hardware and other tools that improve the performance of computer systems.

5.2.4 Cryptography and Information Security

The aim of this area is to secure information being transmitted, received and stored. It is premised on the practice of protecting information from unauthorized access, copyright infringement and other forms of tampering. Computer Engineers in this specialization work on coding to detect and correct errors caused

by distortions in the process of transmitting, storing or compressing information. Cryptography is also a research area in this specialty which utilizes the knowledge of encryption to protect data by transforming the data or information into a form unusable for unauthorized users. Newer methods are constantly developed for protecting various information, such as digital images, speech and music and other forms of data in communication systems especially in wireless networks.

5.2.5 Mobile Computing and Distributed Systems

In this specialty, integrated environments are built for computing, communications, mobility and information access over varying underlying technologies. Computer systems are built to be smarter, smaller, faster and more mobile and adaptable to changes and interconnection. Specific projects in this area include shared-channel wireless networks, improved Ethernet cluster wired systems, platform creation for adaptive computing and seamless memory over heterogeneous wireless networks, development of improved personal digital assistants and mobile devices, adaptive resource management in various systems, improving the quality of service in mobile and ATM environments.

5.2.6 Software Engineering

This specialty employs the knowledge of software engineering to design compilers and operating systems that are compatible with the new trends in computer operations. Computer Engineers in this area of specialty develop and implement algorithms for improved operating system architecture and updates, program analysis techniques, novel quality assurance techniques and compilers that can fit into the recent trends in computing challenges. Examples of work in this field include development of new operating systems for micro and super computers, post-link-time code transformation algorithm development.

5.2.7 Computational Science and Engineering

This area of computer engineering aims to solve complex mathematical problems existing in the challenges that confront our world from an engineering point of view using computational methods. Computer Engineers in this area work through the challenge of designing systems and devices that are robust and efficient enough to perform optimally in any environment placed. This means mathematically considering all possibilities and constraints to minimize to the barest minimum any form of system failure. Designs include radar detection systems, sonar navigation techniques, plasma processing of nanometer features on semiconductor wafers, aircraft design, VLSI circuits and applications and much more.

5.2.8 Computer Vision and Robotics

In this area, computer engineers focus on developing visual sensing technology where intelligent computer systems are built to take in diverse parameters and characteristics of an environment as input while sensing it and then presenting the output as a representation of the environment in three-dimensional view. The three-dimensional output is then implemented to perform a variety of tasks, manipulations and decisions. These include improved human modeling, image communication, and human-computer interfaces, assembly, navigation, detection and surveillance. Roboticians study the many other aspects of controlling robots such as modeling the robot's navigation environment, planning its actions and ensuring safety, modeling its physical properties, directing its mechanisms efficiently, using sensors to provide feedback while taking decisions autonomously. Effort is also made in research to improve the dexterity of robots and adaptability to the human environment.

5.2.9 Digital Signal Processing

The focus in this area of research is to improve human-computer interaction, including speech recognition and synthesis, medical and scientific imaging, or communications systems. Computer Vision development is included in this specialty which enables computer recognition of the physical features in a specified environment and representation schemes to build databases. Speech and handwriting recognition systems are also better developed. Research results from image and speech processing are directed at building human-computer interfaces in line with the diversity of computer users and applications. The aim is the development of better interfaces and experimental evaluation of their effectiveness. Improvement in computer access is as well developed for people with disabilities; program use is simplified along with the development of three-dimensional input and output devices for virtual reality. Example of this could be the development of heads-up displays for aircraft instruments in which critical information such as speed, altitude, and heading are displayed on a screen in front of the pilot's window; dynamic MRI (Magnetic Resonance Imaging), fast computed tomography, electron microscopy, laser imaging of ocean mines and much more.

5.3. USE OF VARIOUS EQUIPMENT IN COMPUTER ENGINEERING FOR VARIOUS PROCESSES

The following equipment are mandatory in each laboratory: Standard topnotch PCs as workstations, Standard servers, Computer Accessories: Printers, Web

Cams, Electrical / Electronic Accessories, All-in-one electronics bench, power supplies, Workshop tools.

Images of Some Sample Equipment



- Arbitrary Waveform Generator: A device for generating electrical waveforms



- Digitizing Oscilloscopes: A device For signal analysis



- DC Power Supplies: A device for Supplying DC voltage to its loads



- FPGA Boards : A device for implementing logical functions



- Device Programmer A device for Configuring programmable non-volatile



- Freescale Development Systems : A device for software development and performance evaluation



Programmable Automation Controllers: A device for automation of electromechanical Processes.



- Spectrum Analyzers : A device for analyzing the spectrum of signals



- Ethernet routers and switches : Device used in networking



- Wireless nodes A device for gathering sensory information



Spectrophotometer: A device used in photonics for light intensity measurement



Robotic arm:
A device used in robotics

5.4 PROSPECTS AND JOB OPPORTUNITIES IN COMPUTER ENGINEERING

A degree in computer engineering opens up a wide range of career opportunities for the graduate. A new graduate in computer engineering will face a bright and challenging future, with positions to be found in research, design and development, manufacturing, marketing, management and other areas.

Most entry-level computer engineering jobs require at least a bachelor's degree in computer engineering. Computer engineering graduates typically have some of the highest starting salaries in engineering. Some large firms or specialized jobs require a master's degree. It is also important for computer engineers to keep up with rapid advances in technology. Therefore, computer engineers are encouraged to continue learning throughout their careers. Computer engineers usually have the option of becoming a Computer Hardware Engineer or a Computer Software Engineer or blend of the two. The following are their prospects:

5.4.1 Design and Development of Computer Hardware

Computer hardware engineers research, design, develop, and test computer hardware and supervise its manufacture and installation. The work of computer hardware engineers is very similar to that of electronics engineers, but except that computer hardware engineers work more with computers and computer-related equipment. In addition to design and development duties, computer hardware engineers may supervise the manufacture and installation of computers and computer-related equipment. The rapid advances and discoveries in computer technology are largely a result of the research, development, and design efforts of computer hardware engineers. To keep up with these technological advances, these engineers must continually update their knowledge.

5.4.2 Design and Development of Computer Software

Computer software engineers apply the principles and techniques of computer science, engineering, and mathematical analysis to the design, development, testing, and evaluation of computer software to improve performance in various spheres of application. Software engineers working in applications or systems development analyze the needs and requests of users and then develop softwares to suit these needs. Maintenance, updates, performance evaluation is also performed from time to time to ensure that the optimal performance of these systems. Software engineers can be involved in the design and development of many types of software, including software for operating systems and network

distribution, and compilers, which translate high level programming languages to machine languages for execution on the computer

5.4.3 Computer Applications Software Engineers and System Software Engineers

Computer applications software engineers analyze users' needs and demands and then design specialized utility programs and applications in line with the users' requests and to solve specific problems. Systems software engineers configure, implement, and install complete computer systems. They sometimes constitute members of the marketing or sales unit functioning as the primary technical resource for sales workers and customers. They also may be involved in product sales and in providing their customers with continuing technical support and after sales service.

5.4.4 Network and Computer Systems Administrator/Network System and Data Communication Analyst/ Database Administrator/ Computer Systems Analyst

Typical industries hiring computer engineers, include software industries, financial services, computer manufacturers, telecommunication industries, chemical companies, defense and security institutions, educational institutions, immigration, consulting, transportation, manufacturing, and consumer goods.

5.5 RELEVANT PROFESSIONAL BODIES IN COMPUTER ENGINEERING

The following are relevant professional bodies in the field of computer engineering:

- i. Council for the Regulation of Engineering in Nigeria (COREN)
- ii. The Nigerian Society of Engineers (NSE)
- iii. Computer Professionals Registration Council of Nigeria (CPN)
- iv. Nigerian Computer Society (NCS)
- v. IEEE Computer Society
- vi. National Society of Black Engineers (NSBE)
- vii. The Association of Computer Engineers and the Association of Computer Engineers and Technicians (ACE-ACET)
- viii. National Academy of Engineering
- ix. The Institute of Software Practitioners of Nigeria (ISPON)
- x. Nigerian IT Professionals in America (NITPA)
- xi. IEEE Computational Intelligence Society
- xii. IEEE Robotics and Automation Society
- xiii. IEEE Systems, Man and Cybernetics Society

5.6 THE ROLE OF COMPUTER ENGINEERS TO HUMANITY

Computer engineers are involved in almost all spheres of human endeavor since computers have become inevitable part of everyday living. The design, maintenance and improvement of these computer systems which have become ubiquitous in every sector are the responsibilities of computer engineers. They therefore directly and indirectly among so many other duties perform the following tasks to help humanity:

- (i) Devise and undertake a regular service programme of both hardware and software of computer systems in all institutions and industries utilizing these systems.
- (ii) Analyze problems and proffer solutions by building applications and embedded systems to aid human effort and resolve challenges.
- (iii) Assist with engineering site preparation using computer aided design techniques and innovations and installation of large computer systems.
- (iv) Setup computer networks to connect computers systems in various sectors and units to enhance communication and teleoperations such as telemedicine, teletraffic, telecommunication etc
- (v) Assist staff in various establishments to setup computer hardware systems that would suit their needs along with the associated equipment and software that would enhance smooth running of operations and resolution of computer-related problems.
- (vi) Manage projects using well developed project management softwares custom-designed to suit the needs of the company and adaptable to various units of the establishment.
- (vii) A hardware design engineer along with the planning, designing and maintenance of hardware equipment of computers help to monitor the development of hardware according to design specifications and carry out repairs and testing of computer equipment in establishments.
- (viii) A network/systems engineer in addition to aforementioned duties ensures that the existing networks are effective and researches into how to develop and improve the capacity of communication channels to tackle the recent challenges in telecommunication relating to the management of radio resources.
- (ix) Computer engineers help to advance research in the line of creating autonomous and decision support systems that can aid human effort in various places. For example, repetitive tasks can be more cheaply, quickly and accurately carried out compared to what humans will do when faced with such tasks.

- (x) Computer engineers in the field of robotics have helped to build advanced humanoid, explorer and navigation robots that work effectively and almost independently in multitasking environments such as in hospitals, automobile assembly industries, electronic assembly plants etc. These robots are also very effective and useful in environments that pose great danger to humans such as in oceans while searching for sunken ships or aircrafts, in fire disasters or while cleaning up nuclear wastes.
- (xi) Software engineers also play significant roles in transforming our social life by creating, designing, improving and maintaining the multimedia software in music players, games, television sets and public address systems etc. Transfer of data, music or video files are now easier than ever using technologies such as Bluetooth and other wireless based connectivity techniques.
- (xii) Computer engineers have also made and continue to make impact in the domestic life of humans as improved computer system softwares and capabilities have been embedded into domestic appliances such that almost all appliances used in the homes have now become smarter and easier to use with the ability to almost think on their own. Washing machines, dishwashers, microwaves and many more appliances are better programmed to suit the needs and desires of the users.
- (xiii) The world is fast becoming a global village through improvement in the quality of social networking sites and their enhanced capabilities which is one of the roles of a computer software engineer in advancing the effectiveness and capabilities of the internet. Communication is indeed much easier, much faster and much more effective.
- (xiv) Security has also been enhanced through the creation of more sophisticated information protection softwares by computer engineers in the line of encryption. Unauthorized invading of personal and sensitive data can now be avoided using tools developed by computer engineers.
- (xv) Computer engineers have contributed immensely to the quality Computer aided design (CAD) softwares and computer aided manufacturing (CAM) techniques by joining isolated computerized systems into integrated networks to boost the productivity of many factories.

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CHAPTER 6

ELECTRICAL AND ELECTRONICS ENGINEERING DISCIPLINE

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COURSE SYNOPSIS

Electrical and Electronics Engineering

Introduction to electrical and electronics engineering profession: Definition of electrical and electronics engineering. Specializations/ Options in electrical and electronics engineering. Use of various implements and equipment in electrical and electronics engineering for various operations/process. Prospects and job opportunities in electrical and electronics engineering as a profession. Relevant regulatory bodies and societies in electrical and electronics engineering. The role of electrical engineers in advancement of humanity.

6.0 INTRODUCTION TO ELECTRICAL AND ELECTRONICS ENGINEERING DISCIPLINE

6.1 DEFINITION

Electrical Engineering is the historical name for what is now called Electrical and Electronics Engineering and/or Electrical, Electronic and Computer Engineering. Originating in the 19th century with the development of electric power and the advent of telephone and wireless communications, Electrical and Electronics Engineering continues to have lasting impact not only on engineering and technology profession, but on all aspects of societal developments. Recent advances such as integrated computing and communications systems and the proliferation of microchips and microelectronic hardware have revolutionized the present day existence in terms of life; work as well as how we interact as a society and even on our social life.

Electrical and Electronics Engineering is an application of science, technology, and problem-solving skills to conduct research, design, develop (or construct), test, and oversee the manufacture of electrical and electronic equipment and devices as well as maintain products, services, and information systems.

Electrical and Electronics Engineers (EEE) design, develop, test, and supervise the manufacture of electrical and electronic equipment. Some of these equipment include broadcast and communications systems; computers; electric motors;

machinery controls; lighting; wiring in buildings; automation systems; automobiles, aircraft, radar and navigation systems as well as power generating, controlling, and transmission devices used by electric utilities. Electrical Engineers also engage in the design and development of new technologies to generate, store, transmit, control and convert energy and information. From the global positioning systems (GPS) that can continuously provide the location of a vehicle to giant electric power generators, electrical and electronics engineers are responsible for a wide range of technologies.

Much of the advanced equipment found at home or workplace such as entertainment systems, domestic appliances, personal computers, data processing equipment, robots and machine tools are made possible by Electrical and Electronics Engineering.

6.2 SPECIALIZATIONS / OPTIONS IN ELECTRICAL AND ELECTRONICS ENGINEERING

There are several areas of specialization available in Electrical and Electronics Engineering. They may study/work in design, research and development, production or management positions at government agencies or private corporations where they may specialize in any of the underlisted areas. The following are available options but not limited to the specialization in Electrical and Electronics Engineering:

6.2.1 Electronics and Telecommunications Engineering

Electronics and Telecommunications Engineering, is an electrical engineering discipline that brings together electrical engineering with computer science in order to enhance telecommunication systems. Telecommunication engineering links heavily with what is generally grouped as broadcast engineering. A telecommunication engineer is responsible for designing, monitoring and installation of telecommunications equipment and facilities, such as complex electronic switching systems, wired and wireless telephone facilities, and fiber optics. Telecommunication is a diverse field of engineering which is connected to electronics, civil, structural, and electrical engineering. Ultimately, telecom engineers are responsible for providing the method for customers to have telephone and high-speed data services. The understanding of telecommunications engineering helps people who are closely working in political and social fields, as well as accounting and project managements.

Telecom engineers use a variety of equipment and transport media available from a multitude of manufacturers to design the telecom network infrastructure. The

most common media, often referred to as plant in the telecom industry, used by telecommunications companies today are copper, coaxial cable, fiber, and radio. Telecom engineers are often expected, as most engineers are, to provide the best solution possible at the lowest cost to the company. This often leads to creative solutions to problems that often would have been designed differently without the budget constraints dictated by modern society. In the earlier days of the telecom industry, massive amounts of cable were placed that were never used or have been replaced by modern technology such as fiber optic cable and digital multiplexing techniques.

In schools, it is taken as an option in Electrical and Electronics Engineering or run as a department under general Engineering faculty depending on the capacity of the institution. Students wishing to establish themselves in this field must be sound in basic science courses, general engineering mathematics, electronics, Communication theory, software designs; installation and operations, and elementary and sophisticated Computer programming.

Some of the courses taken under this option in university of Ilorin include Communication Engineering Principles, Satellite Communications, Mobile and Personal Communications, Digital Signal Processing, Broadcasting and Internet Technology etc.

6.2.2 Computer and Control Systems Engineering

Control Engineering or Control Systems Engineering popularly referred to as Computer and Control Systems Engineering is the engineering discipline that applies control theory to the designing of systems with expected or desired behaviours. The practice uses sensors to measure the output performance of the device being controlled and those measurements can be used to give feedback to the input actuators that can make corrections toward desired performance. When a device is designed to perform without the need of human inputs for correction, it is called automatic control. Being multi-disciplinary in nature, control systems engineering activities focus on implementation of control systems mainly derived by mathematical modeling of systems of a diverse range. It also involves writing a comprehensive algorithm from the mathematical models for translation into an appropriate computer programming for the desired performance.

In schools, this is also taken as either an option in Electrical Engineering or as a department on its own under general engineering faculty. Students who wish to establish themselves in the area must be solid in general engineering mathematics, computer programming, electronics, electrical machines, control theory etc

In University of Ilorin, some of the courses taught under this option include Control Engineering, Microprocessor Hardware and Software Techniques, Digital System Design and VHDL programming, Digital Control Engineering etc.

6.2.3 Power and Machines Engineering

Power and Machine Engineering also known as Power and Energy Systems studies electric power generation, transmission and distribution systems as well as renewable energy technologies by utilising well defined techniques and available potential energy sources including its economic implications. World primary energy resources such as fossil fuels, renewable energies, nuclear energy are utilised to prescribe solutions to present situation, trends, and future developments in the areas of power systems. Sustainable energy system and environmental impact of energy conversion and use have become the order of the present day world as it largely affects the economy and so is given priority in the present day energy systems studies. Power and energy systems research emphasizes all aspects of electrical energy, innovation in energy generation and delivery, alternative resources, and efficient devices, conversion, delivery and use of energy in electrical form. The activity ranges from controls for large utility systems to energy harvesting devices for micro-sensors. The growth of solar energy, wind energy, and other resources, combined with trends such as electric and hybrid vehicles will have profound impact on global society.

Largely, Power and Machines or Power and Energy systems as it is called in some cases, focuses on three major subdivision; this includes Power Systems, Power Electronics and Electrical Machines. Power systems is the area concerned with the most economic, most reliable ways to assemble and operate a large electric power network, given its inherent nonlinearities and uncertainties; Power electronics deals with a developing a better, more reliable ways to design, analyze, and control switching power converters; while Electrical Machines deals with the study of devices for converting motion into electromagnetic energy and vice-versa.

Though power and machines is run as an option in some schools, each of the subdivision is run as a department (for wider syllabus) or in some other cases taken as an option in the department of Electrical and Electronics Engineering. Students wishing to establish themselves in this area of electrical engineering must be sound in basic science courses, general engineering mathematics, electronics, Control theory, electrical machines and power systems theories.

In University of Ilorin, some of the courses taught under this option include Electric Power principles, Electric Power Systems Engineering, Power Systems Communication and Control, Electrical Machines, Electrical Energy Conversion and Storage, Computer Application in Power Systems, Electrical Machines Design etc.

Other areas in electrical and electronics engineering include Energy Systems Engineering, Microprocessors and microcomputers, Analog and Digital Electronics Engineering, Optoelectronics, Electronic Circuit Design Engineering, Bioelectronics Engineering, Measurements, Instrumentation, Remote Sensing, Microelectronic Design and fabrication, Robotics and Automation Engineering, Microwaves, Radar Technologies, Antennas etc

6.3 USE OF VARIOUS INSTRUMENTS, EQUIPMENT AND APPARATUS IN ELECTRICAL AND ELECTRONICS ENGINEERING

In the field of Electrical and Electronics Engineering, there are myriads of instruments, equipment and apparatus used in measuring and testing of circuit elements and parameters as well as determining the circuit behaviours usually displayed in form of waveforms. These instruments, equipment and apparatus could be categorised into analogue or digital device. They could also be basically grouped into software or hardware. A very interesting thing is that all physical circuits and their elements exist in digital form and can also be designed, measured and simulated in digital modes. Various digital laboratories exist which will immensely assist students' practical understanding. It is therefore strongly recommended for students to acquaint themselves with the use of the laboratories. Such laboratories include Livewires, proteus, NL5 Circuit Simulator, MATLAB, iCircuits, xCircuits, CEDAR Logic Simulator etc to mention but a few. There are numerous softwares available online and more are still being released by the day.

Testing and measurements of values of circuit elements such as resistors, capacitors, inductors, diodes etc can be determined simply by using an instrument known as multimeter (A hybrid of basically Ohmmeter, Voltmeter, Ammeter). Instruments such as spectrum analyser, motor drive analyser, Mixed Signal Oscilloscope, instrument transformers etc are also often used.

Equipment could be some complex machines like transformers, Hand Tools such as Soldering iron, set of screw drivers, cutters, or complete electrical tool kit to be precise; it could be PCB based tools such as Trace Resistance, Impedance calculator; it could be RF tools e.g RF Unit converter, filter circuit tracer etc; it could be schematic tools such as schematic capture tools; Circuit Simulators for drawing circuits as well as simulating them e.g Livewire, NL5 Circuit Simulator,

iCircuits, xCircuits, CEDAR Logic Simulator etc passive tools such as Resistor Value Table or even digital toolbox

Apparatus here refers to any flexible-circuit set-up which allows for accommodation of some number of experiments called modules. Microchip Based Standard Modules which are designed to accommodate several experiments, measurements and Testing such as 'Skill G', Arduino boards, Galileo boards etc are perfect examples. Also, they could be in form of machines set up for some particular experiments such as Transformers (open and short circuit tests), Induction motors Since advancement has been made in the areas of automation, use of predesigned flexible circuit board.

Some of the images of the equipment are shown below



Digital Multimeters

(a)



Analog Multimeters: is a multi-function meter basically used for measuring current, voltage and resistance. It can be analog or digital. (a) Digital Multimeters
(b) Analog multimeter



An Oscilloscope: It is a laboratory instrument commonly used for displaying and analysing the waveform of electronic as a function of time.



An Electrical/Electronic Toolbox: A basic electrical/electronic



A Soldering iron: A hand tool used for joining component to component and to Vero boards.



A Roll of Soldering Lead: This is melted with the use of soldering iron to form joint between components, component and board

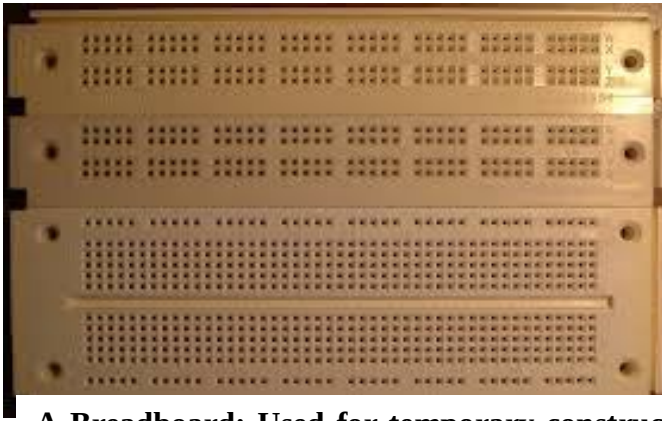


A sample of Software Package



Crimping Range: For Cu 10-120mm²

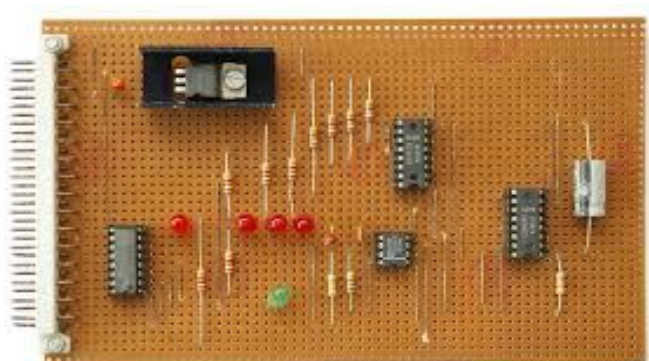
Crimping Tool: It is used for joining two pieces of Cu wires.



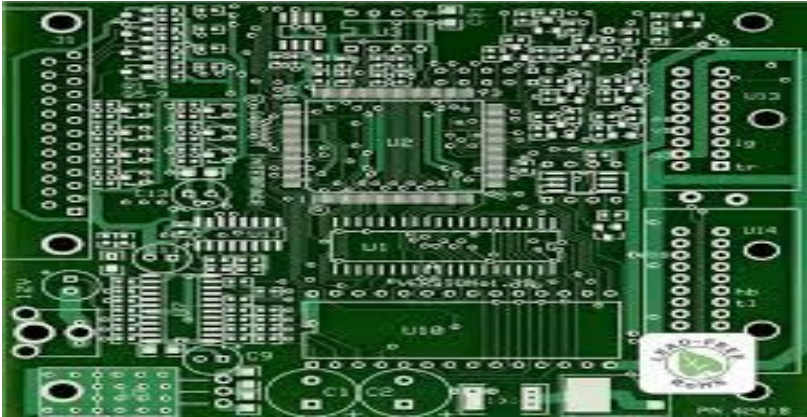
A Breadboard: Used for temporary construction of electronic circuits



Arduino Board: A module which basically allow for control of appliances



Vero Board: Used as a mount for soldered components



12 A Printed Circuit Board: A layout containing connections for ease of mounting components.

6.4 PROSPECTS AND JOB OPPORTUNITIES IN ELECTRICAL AND ELECTRONICS ENGINEERING AS A PROFESSION.

There are unlimited opportunities for Electrical and Electronics Engineers to fit in well to the society. Below are some of the key industry sectors where the services of Electrical and Electronics Engineers are needed

6.4.1 Telecommunications

Telecommunications is a prime growth area for Electrical and Electronics Engineers. The growth is spurred by the worldwide deregulation, which has lead to more players trying to make it on the field. The number of employers is expanding in such services as Local area networks both radio and wired within buildings and campuses as evident in University of Ilorin, Wire and optical links to homes and businesses, Satellite communications in unwired Third World countries, Satellite communications for mobile telephone users everywhere, Satellite, microwave, and fiber-optic trunks for inter-city traffic, Databases ranging from internet sites to collections of specialized technical information, Digitization of broadcasting stations etc

6.4.2 Energy and Electric Power Sector

Power engineers deal with energy generation by a variety of methods -- turbine, hydro, fuel cell, solar, geothermal, and wind, for example. They also deal with electrical power distribution from source to consumer and within factories, offices, hospitals, laboratories, and they design electric motors and batteries. In industry, power engineers are employed wherever electrical energy is used to

manufacture or produce an end product -- petrochemicals, pulp, paper, textiles, metals, and rubber, for example. They are needed to design electrical distribution systems and instrumentation and control systems for the safe, effective, efficient operation of the production facilities. As the average age of the engineers in this job area approaches the mid-to-late forties, companies will begin to hire young engineers in large numbers. Jobs in these industries are usually in abundance.

6.4.3 Computers

The computer industry serves many industrial sectors, including aerospace, transportation, construction, telecommunications, power, medicine, and automated manufacturing and even offices. The industry is strong and growing, in part because of the desire of corporate bodies to reduce its dependence on large, expensive centralized systems based on mainframes, and instead to opt for more flexible architectures like client/server networks, or private "intranets" based on Internet technology, separated by a protective firewall to maintain local security for proprietary materials. Even more compelling, individuals and companies alike have embraced the World Wide Web as an information source, communication medium and market for goods, creating a seemingly insatiable demand for advanced software, high-speed modems, and more powerful PCs are well appreciated in the applications of computers. Many employers in the computer industry find it difficult to fill the positions created by growth. Demand is especially strong for those whose knowledge and skills integrate hardware and software, as hardware/software co-design gains in popularity thereby giving Electrical and Electronics Engineers a large variety of options in this field regarding their future career.

6.4.4 Semiconductors

The chief enabling technology at the heart of the electronic components booming computer industry is semiconductor technology, in particular the development and manufacture of integrated circuits. As integrated circuits companies strive to search for faster and more powerful chips, they seek engineers to investigate new materials and improved packaging -- engineers who can handle the challenge of competitive pressure and ever-shorter development time. Manufacturers of microprocessors and memory chips for example, continuously improve existing products and introduce new ones to beat the competition and meet customers' expectations of ever-higher performance. Semiconductor products include not just digital ICs but also analog chips, mixed-signal (analog and digital) integrated circuits, and radio-frequency (RF) integrated circuits. Another important sector

deals with power semiconductor devices for power control in manufacturing, transportation, and electrical distribution.

6.4.5 Aerospace

Electrical and electronics engineers in the aerospace field, design and develop electronics and power equipment for aircraft, helicopters, and spacecraft. Displays, controls, communications, and navigation are important aspects of the field, as are simulators for training and development. Military systems for land, sea, and air also come under the aerospace category.

Defence and aerospace companies still employ hundreds of thousands of Electrical and Electronics Engineers, even though the aerospace industry has faced some hard times in recent years. Prospects in the two major branches of the industry are looking brighter. Defence systems are a major priority for most nations especially; Nigeria which is currently facing seemingly unending terror attacks. Interests in space exploration and travel will be an added advantage. Hence, new satellites are needed to meet swelling demand for global communications. Electrical Engineers are therefore needed to be on deck in the design, operations and maintenance of satellites.

6.4.6 Bioengineering

This wide-ranging field, alternatively referred to as biomedical engineering, was created some 30 years ago by the merging interests of engineering and the biological /medical sciences. Some of the representative bioengineering activities include the design of diagnostic and therapeutic devices for clinical use, the design of prosthetic devices, the development of biologically compatible materials, and the application of state-of-the-art technology to biological research. This field has grown tremendously since its inception; now more than 100 universities offer training programs that are funded by hundreds of millions of dollars across the globe. Bioengineering is an interdisciplinary field with employers in many sectors but more of Electrical and Electronics Engineers. Bioengineers work with other health care professionals as members of a team.

The biomedical engineer must learn to think of biology in new ways in order to develop new tools for diagnosing disease and to repair or replace diseased organs. Many of the major advances in this field now seem almost common place: pacemakers, blood analyzers, cochlear implants, medical imaging, lasers, prosthetic implants, and life support systems are just a few of the results of the team efforts of biomedical engineers and health professionals.

6.4.7 Manufacturing

Manufacturing technology has become more important in recent years as global economic reality has forced companies to re-evaluate basic manufacturing techniques in order to remain competitive. In pursuit of increased productivity, companies have introduced such innovations as just-in-time parts supply, six-sigma quality goals, statistical process control, and robotic assembly cells. Even small companies have transformed their ad hoc approach to process development into rigidly controlled and monitored systems, well understood in terms of mathematical models, where the effects of random events can be quickly detected and corrected.

Thus there is a widespread application of the manufacturing sciences in the workplace today, from automation on the production line to management techniques to environmentally friendly methods of manufacturing. Electrical Engineers are therefore needed in the machineries design and operation, computer monitoring and control, general automation of various manufacturing processes as well as repairs and troubleshooting of the machineries.

6.4.8 Services and Other Professions

Many electrical and computer engineers and computer scientists find that their technical background makes them well suited for a variety of work in other industries. For example, the service industry has become a major employer of engineers and computer professionals.

Some find work that directly corresponds to their professional training. The entertainment industry hires engineers for a variety of projects; in the entertainment industries, for example, electrical and computer engineers are recruited to handle their Imagineering tools and to help create animated films. The banking and finance industry has many computer-related positions that need engineers to manage rapid-trading activities like the Internet Banking, ATM design and operations, electronic queuing managing systems etc. Many organizations use the talents of computer professionals to create, store, and transmit data and to create and manage systems for operation. Although individually, these industries do not employ a large number of engineers, in combination they add up to a large whole. Engineering majors can thus look to industries where they can apply their technical knowledge and skills in fields that may not be high-tech in themselves.

6.4.9 Education and Research

Many electrical engineers, computer engineers, and computer scientists interact with educational and research institutions or industrial labs. Some go straight into college and university teaching and research after completing their PhD degrees. Others, including those with master's degrees, may teach on a part-time basis while holding a full-time job with another organization or on a full time basis and/or as an independent consultant.

Opportunities also abound in continuing professional education, such as short courses designed to update engineers. Taught by faculty as well as consultants with industrial experience, these courses are offered to employees on site as well as off site. Engineers with expertise in timely subjects can also give papers and publish articles and books that bring them recognition and put them in line for consulting work.

6.4.10 Transportation and Automotive

This industry spans many areas. Transportation can include railroads, shipbuilding, and traffic management. What these disparate areas have in common is that employers rely on increased use of electronics merged with other engineering disciplines. It includes electronics for internal and external communication, navigation, failure detection, and displays of many types. Many vehicles are directed and accelerated by fault-tolerant electronics. Electric power is generated and distributed within most vehicles. Ships are wired like small cities for power and information. The domain of mechanical and civil engineering, transportation and automotive areas have many job opportunities for electrical engineers from various technical specialties, including communications, computers, and control systems.

6.5 RELEVANT REGULATORY BODIES AND SOCIETIES IN ELECTRICAL AND ELECTRONICS ENGINEERING

There are various schools responsible for the tutoring of various engineering courses at tertiary levels and are often accredited to ensure compliance with the laid-down curriculum towards ensuring standard program. In Nigeria, the National University Commission (NUC) and the Council for the Regulation of Engineering Practice in Nigeria (COREN) are responsible for carrying out the accreditation of the program from time to time. The purpose of this program is to help attract a diversified pool of talented students into research careers in the various fields, and to help ensure that they receive the best education possible.

Generally, engineers are guided by laid down regulations to ensure uniformity and standard. There are several of codes and standards by various bodies. More

apparent is that of the Institute of Electrical and Electronics Engineers (IEEE), a professional body established in the United State leading in the areas of coming up with rules and regulations which now generally adopted. In carrying out any design work, installations and even operations, these rules must be strictly adhered to in order to ensure flexibility, ethics and standard. Other professional bodies include Electrical Testing Laboratories, Inc. (ETL); Electric Power Research Institute (EPRI), Nigerian Society of Engineers (NSE) etc

6.6 THE ROLE OF ELECTRICAL AND ELECTRONICS ENGINEERS IN ADVANCEMENT OF HUMANITY.

The technical-know-how of EEE is required to drive through any meaningful development in any society. Some notable role of EEE in the advancement of humanity include;

- (i) Ensuring growth in Telecommunications industry by research inputs, technical supports in terms of workmanship and consultancy
- (ii) Developing and repairing electronic and electrical health facilities for managing health risks
- (iii) They are responsible (with other relevant engineers) for power generation, transmission and distribution for both homes and industries.
- (iv) They assist in transportations which include railroads, shipbuilding and control, and general traffic management.
- (v) In the areas of security, electrical engineers develop various automation systems for verification and access as well as alert in case of security breach.
- (vi) In economic growth, electrical engineers develop systems that not only lead to job creation but seeing to faster execution rate of jobs through systems hardware and software designs for industries and organizations.

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CHAPTER 7

FOOD AND BIOPROCESS ENGINEERING DISCIPLINE

J.O.Olaoye and M.M. Odewole

COURSE SYNOPSIS

Food and Bioprocess Engineering

Introduction to food and bioprocess engineering profession: Definition of food and bioprocess engineering. Specializations/ Options in food and bioprocess engineering. Use of various implements and equipment in food and bioprocess engineering for various operations/process. Prospects and job opportunities in food and bioprocess engineering as a profession. Relevant regulatory bodies and societies in food and bioprocess engineering. The role of food and bioprocess engineers in advancement of humanity.

7.0 INTRODUCTION TO FOOD AND BIOPROCESS ENGINEERING DISCIPLINE

7.1 DEFINITIONS

Food – It is simply any substance consumed to provide nutritional support for the body. In a broad sense, food is any edible substance (usually of animal or plant origin), consisting of nourishing and nutritive components such as carbohydrate, fat and oil, protein, essential minerals and vitamins, which when ingested and assimilated through digestion sustains life, generates energy and provide growth, maintenance and development of human body.

Bioprocess – Bioprocess is any specific operation that uses complete living cells or their components (e.g bacteria, enzymes etc.) to obtain desired end products.

Engineering –It is the discipline and profession that deals with acquisition and application of scientific, mathematical, economic, social, and practical knowledge to design, build and maintain structures, machines, devices, systems, materials and processes that safely realize a solution to the needs of the society.

Also, it is the field of study in which the knowledge of mathematical and natural sciences gained by study, experience and practice is applied with a good sense of judgment to develop ways to economically utilize the materials and forces of nature for the benefit of mankind.

Bioprocess Engineering- It is the alteration or application of renewable materials to generate value-added products. It deals with the design and development of equipment and processes for manufacturing of products such as food, feed, pharmaceuticals, nutraceuticals, chemicals, papers, fuel etc. from biological(living) materials.

Food Engineering –It is branch of engineering that deals with design, construction, maintenance and operation of food processing equipment.

It can also be defined as the application of relevant engineering principles to food and other raw materials for the production of useful edible products and by-products.

The main objective of Food and Bioprocess Engineering is to develop quality value added products in good quantity from food materials and other relevant living organisms.

The Food and Bioprocess Engineering program is designed to capture the essential features of both food science and engineering education. The programme provides opportunity to work on pilot-plant studies and manufacturing systems. In short, Food and Bioprocess Engineering graduates are engineers with a strong food science education.

7.2 Specialization- Options in Food and Bioprocess Engineering

Some of the areas of focus of Food and Bioprocess Engineering profession are stated below:

7.2.1 Machine Design Engineering:

It is the branch of food and bioprocess engineering that deals with the development of machines and equipment needed in the production of processed food and bioprocessed products. In the development of new products, many unit operations are involved; some of which are-handling of raw materials, cleaning, material separation, size reduction, forming, pumping, mixing, heat addition, heat reduction. All these operations require the use of one or more machines/equipment, as a result of these, engineering and scientific streams of knowledge are used to design, modify or develop new machines/equipment needed for the specific operations to take place.

7.2.2 Storage and Packaging Engineering:

Storage is the safe keeping of products in condition (s) that would maintain their best quality and quantity until when they would be needed. Packaging is an aspect

of post-production process that deals with confinements in which manufactured products are kept. Packaging may be done to give products better appearance, for proper handling and transporting of products, ease of marketing the products, improvement of product quality etc. This branch of food and bioprocess engineering requires a sound knowledge of engineering behaviours of products and materials under various environmental, production and storage conditions. Information obtained via rigorous engineering/field experiments and tests would help to know the shelf life of manufactured products in storage and packaging materials/containers. It would also help to know when packaging containers/materials for specific products are to be modified or changed based on market trends and consumers reactions. Modification or manufacturing of new storage and packaging containers would be achieved via engineering activities.

7.2.3 Food Bioprocess Engineering:

This is another option in food and bioprocess engineering programme. It mainly deals with the thorough monitoring and control of process conditions. Therefore, knowledge of modelling (especially with computer) is required. (*It should not be confused with food and bioprocess engineering!*). Some processes are involved when specific food and bio-products are to be developed. Some of the processes are: fermentation, clarification, homogenization, pasteurization, drying, freezing, cooling, addition of materials etc. In carrying out process operations, proper care must be taken before, during and after the operation in order to ensure that the quality and quantity of manufactured products are not adversely affected. To achieve that, proper control of governing process conditions must be ensured; in some cases, automation of operations is done.

7.2.4 Bioenvironmental Engineering

It is the use of living organisms coupled with engineering principles to clean up the environment or environmental components.

7.2.5 Biotechnology

It is the use of living organisms, tissues, cells or their molecular components to alter the genetic make-up of living organisms so as to be able to produce another useful products. Biotechnology has been used in the field of medicine to produce antibiotics and vaccines; in agriculture to produce new varieties of plants and breeds of animals. It was also used during world war to produce biological weapons.

7.3 USE OF VARIOUS EQUIPMENT IN FOOD AND BIOPROCESS ENGINEERING

The following are common equipment used in food and bioprocess engineering:

SN	Equipment	Operations
1	Bioreactors	Fermentation operation, biogas production etc.
2	Dryers	Reducing the moisture contents of materials/products.
3	Mixers	For ensuring homogeneous distribution of raw materials.
4	Water baths	For maintaining the temperature of products.
5	Refrigerator	For reducing cooling of products/materials.
6	Autoclave	For sterilization operation.
7	Pulping machine, Cutting machines, Crushers, Shredder, Grinding machine etc.	For size reduction of materials/products.
8	Shaping equipment	For shape forming.
9	Pumps, Fans	For moving fluids, cleaning of equipment.
10	Silos, Bins etc.	For storing products/materials
11	Expellers, Extruders etc.	For liberating oils from oil bearing materials. For liberating liquid extracts from materials.
12	Desiccators	For maintaining the moisture content of products/materials
13	Ovens/moisture meters	For determining the moisture content of material.
14	Sieve Shakers	For determining the

		particle size of material/product.
15	Conveyors, Elevators etc.	For material handling and movement from one point to another during operation.
16	Canning and Bottling Machines	For precise measurement products of into cans and bottles
17	Sealing Machine	Covering of products in containers.



Portable Leaf Area Meter: An instrument for determining surface area of leaves.



Laboratory Oven Model H-30100.4F (O°-300°): An instrument for determining the moisture content of agricultural and biological materials.



TESTO 645 Temperature and Relative Humidity Measurement Data Logger with probe_ A device for measuring temperature and relative humidity of produce in a structure.



IKA Digital Bomb Calorimeter with Digital Cooling System Supply Water Model KV 600:

An instrument used in measuring the heat of combustion of a particular reaction.



Moisture Meter: An instrument for determining the moisture content of materials



Motorized Sieve Shakers: An instrument for determining the particle size of materials/products

7.4 PROSPECTS AND JOB OPPORTUNITIES IN FOOD AND BIOPROCESS ENGINEERING

Human race cannot do without food and other bio-products for her existence and proper functioning. Recall the maxim: *“a hungry man is an angry man”*. Therefore, there are many job opportunities for Food and Bioprocess Engineering graduates in various sectors of human endeavours.

7.4.1 Food and Allied Products Industries

There are various food and allied products industries all over the world. Some of the industries are: Breweries, Fruit juice and Soft drink industries, Beverage industries, Flour making industries, Pharmaceutical industries, Paper Mills, Confectionery industries, Dairy Products Industries, Biofuel Industries, Agricultural commodity processing Industries (Tomato Processing, rice mills, Sugar making industries, Meat and Sea Food Processing, Oil Seeds Processing, Rubber Processing etc.)

7.4.2. International Corporations/Agencies

There are many international corporations/agencies with job opportunities. These bodies have several units/department of which food programmes are included. Some of them are: Food and Agricultural Organization(FAO), United Nations Agencies, World Bank Assisted Programmes, New Partnership for Africa Development (NEPAD), International Fund for Agricultural Development (IFAD), International Institute for Tropical Agriculture etc.

7.4.3. Government Agencies/Ministries/Parastatals

The following are some of the government agencies/ministries/parastatals with job opportunities. Federal and State ministries of Agriculture, National Centre for Agricultural Mechanization (NCAM), Nigerian Stored Products Research Institute (NSPRI), Raw Materials and Development Council, National Cocoa Research Institute, Federal Grain Reserve Centres, Standard Organization of Nigeria (SON), National Agency for Food, Drug, Administration and Control(NAFDAC), Military and Paramilitary Bodies, Government Banks (Central Bank of Nigeria, Bank of Industry, Bank of Agriculture) etc.

7.4.4 Tertiary Institutions

Some tertiary institutions in Nigeria and many in abroad are offering courses in Food and bioprocess engineering or as options in Agricultural Engineering. Yearly, the number of tertiary institutions keeps increasing; therefore more man power is needed to fill up the new institutions and also to replace retired or mobilized personnel.

7.4.5 Self Employment

Food and Bioprocess Engineers can decided to stand on their own after the acquisition of necessary qualification and experience. They can work as independent researchers or venture into equipment sales and servicing; design and construction of machines, manufacturing and sales of processed products; consultancy services or contract staff to organized bodies.

7.5 RELEVANT PROFESSIONAL BODIES

A Food and Bioprocess Engineer in Nigeria for now, is permitted to register with Nigerian Institution of Agricultural Engineers(NIAE). The Nigerian Society of Engineers (NSE) which he/she should also be a member four years after graduation also permits member to join another related society under NSE.

He must also be a member of Council for the Regulation of Engineering in Nigeria (COREN). It is important to note that the title “**Engr.**” before his name must not be used (it is unlawful and punishable) unless he/she has registered with COREN. Other professional bodies are West African Society of Agricultural Engineers (WASAE), American Society of Agricultural and Biological Engineers (ASABE), and any other specific or related ones

7.6 THE ROLE OF FOOD AND BIOPROCESS ENGINEERS IN ADVANCEMENT OF HUMANITY

- (i) Bridging the knowledge gap between theory and practice in matters relating to engineering aspects of development of processed food and bio-products.
- (ii) Identification and provision of feasible solutions to problems related to food processing, storage and utilization.
- (iii) Development of new products and processes that are beneficial to the society through research.
- (iv) Standardization of food and bioprocess engineering equipment, procedures and facilities brought from abroad.
- (v) Formulating, implementing, enforcing and reviewing food and bioprocess policies, programmes and projects that will address the needs of the society.
- (vi) Rendering useful services to the community, private organizations, international organizations and government in form of advice and intellectual opinions.
- (vii) Training of young Engineers, interested groups/association and individuals.
- (viii) Projecting and protecting the good image of the engineering profession at large.

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CHAPTER 8

MATERIALS AND METALLURGICAL ENGINEERING DISCIPLINE

I.N. Aremu

COURSE SYNOPSIS

Material and Metallurgical Engineering

Introduction to material and metallurgical engineering profession: Definition of material and metallurgical engineering. Specializations/ Options in material and metallurgical engineering. Use of various implements and equipment in material and metallurgical engineering for various operations/process. Prospects and job opportunities in material and metallurgical engineering as a profession. Relevant regulatory bodies and societies in material and metallurgical engineering. The role of material and metallurgical engineers in advancement of humanity.

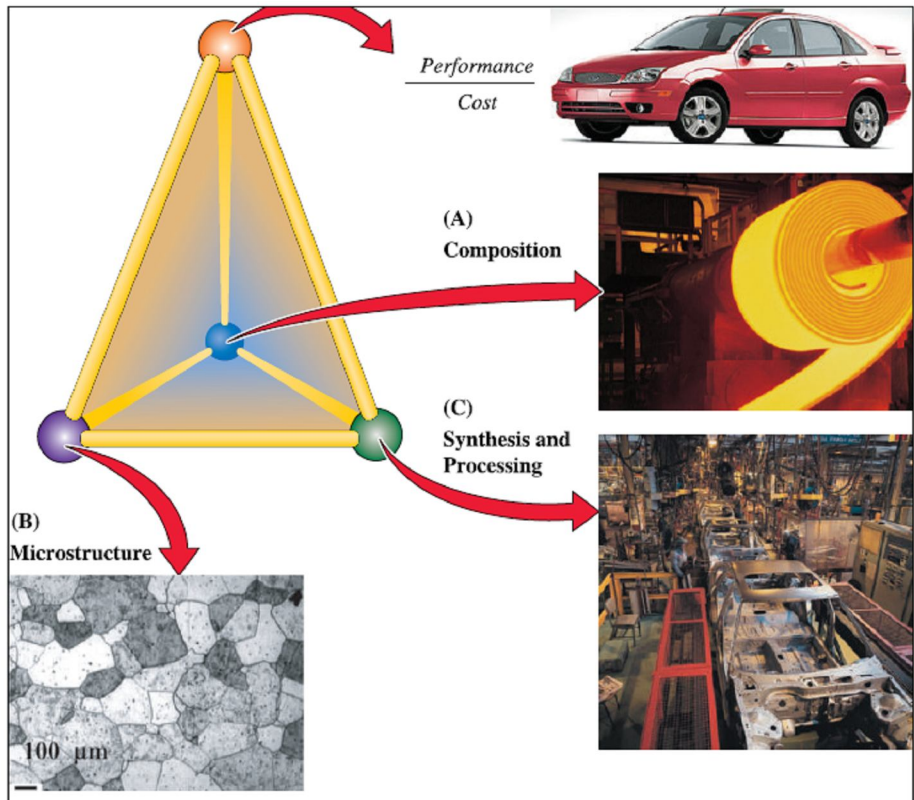
8.0 INTRODUCTION TO MATERIAL AND METALLURGICAL ENGINEERING DISCIPLINE

8.1 DEFINITION

The breadth of training afforded to engineers specializing in metallurgical and materials engineering permits entry into many exciting technical fields. All fields of engineering involve the use of metallic, ceramic, polymeric or composite materials. Virtually every component of any engineered structure is limited by the properties of the materials chosen for its fabrication. The selection, methods of production, heat treatment and finishing of the materials involved in all aspects of systems of transportation, power generation, communication, food preparation, entertainment and housing depend on individuals trained in materials. Exciting challenges exist in the development and application of 21st-century materials, which range from the new generation of superconductors and ultra-lightweight composites to new magnetic recording media and sophisticated high-temperature alloys.

Materials and Metallurgical Engineering involves production, selection and maintenance of metals and other materials for every engineering application. Materials and Metallurgical Engineering is the branch of engineering that involve the choice of different materials to satisfy the requirement of engineers in actualizing various design objectives into specific appliances for the need of humanity. The properties of these materials however determine the scope of its usage which also depend on its microstructure resulting from processing. Hence,

the materials pyramids consisting of structures, properties, processing and application is the scope of study in Materials and Metallurgical Engineering.



MATERIALS PYRAMID DEPICTING RELATIONSHIP BETWEEN PROPERTIES, PROCESSING AND APPLICATION

What therefore is Materials and Metallurgical Engineering?

- The understanding of how the structure and bonding of a material controls the properties
- The understanding of how the properties of a material can be controlled by processing
- Material selection for a wide range of applications

What do Materials and Metallurgical Engineers do?

- They determine the structure of materials
- They measure the properties of materials

- They devise ways of processing materials
- They think about how a material is suited to the purpose it serves and how it could be enhanced to give better performance

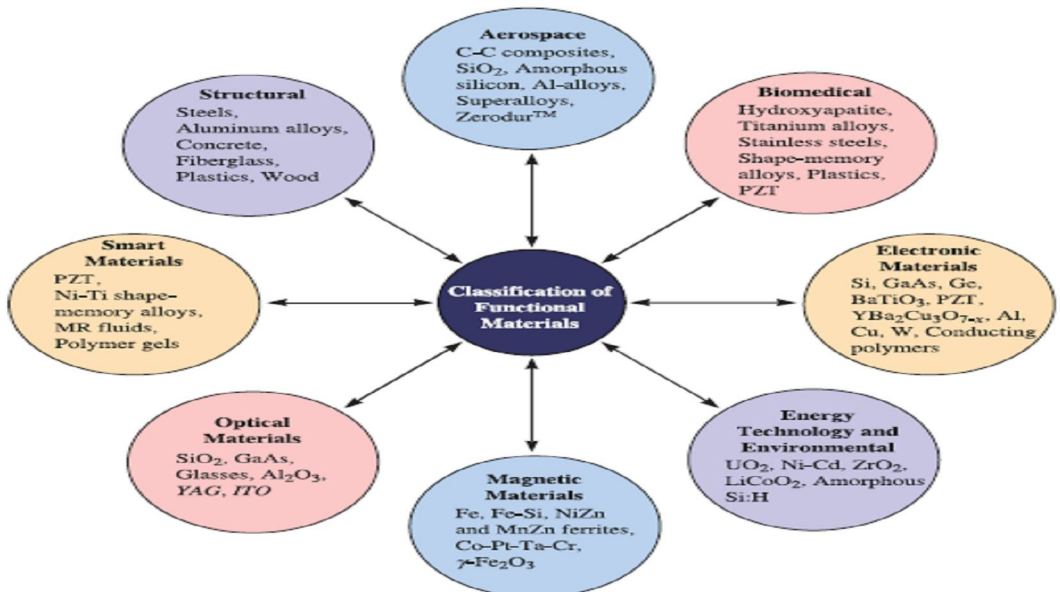
8.2 AREAS OF SOCIALIZATION IN MATERIAL AND METALLURGICAL ENGINEERING

There are different modes of materials classification and these determine various specializations/options:

- One way is grouping materials into the following as contained in table 1-1 below:

	Examples of Applications	Properties
Metals and Alloys		
Copper	Electrical conductor wire	High electrical conductivity, good formability
Gray cast iron	Automobile engine blocks	Castable, machinable, vibration-damping
Alloy steels	Wrenches, automobile chassis	Significantly strengthened by heat treatment
Ceramics and Glasses		
$\text{SiO}_2\text{--Na}_2\text{O--CaO}$	Window glass	Optically transparent, thermally insulating
Al_2O_3 , MgO, SiO_2	Refractories (i.e., heat-resistant lining of furnaces) for containing molten metal	Thermally insulating, withstand high temperatures, relatively inert to molten metal
Barium titanate	Capacitors for microelectronics	High ability to store charge
Silica	Optical fibers for information technology	Refractive index, low optical losses
Polymers		
Polyethylene	Food packaging	Easily formed into thin, flexible, airtight film
Epoxy	Encapsulation of integrated circuits	Electrically insulating and moisture-resistant
Phenolics	Adhesives for joining plies in plywood	Strong, moisture resistant
Semiconductors		
Silicon	Transistors and integrated circuits	Unique electrical behavior
GaAs	Optoelectronic systems	Converts electrical signals to light, lasers, laser diodes, etc.
Composites		
Graphite-epoxy	Aircraft components	High strength-to-weight ratio
Tungsten carbide-cobalt (WC-Co)	Carbide cutting tools for machining	High hardness, yet good shock resistance
Titanium-clad steel	Reactor vessels	Low cost and high strength of steel with the corrosion resistance of titanium

b) Another method is functional classification of materials



Functional Classification of Materials

From the classification of materials as depicted above, the following option/specialization are obtainable:

8.2.1 Metallurgical Engineering (Ferrous and Non Ferrous Metals)

The specialization is basically that of metallic materials. Ferrous metals are essentially Iron, Steel and Alloys which the principal element is Iron (Fe).

8.2.2 Materials Engineering

Ceramic Engineering and Polymer Engineering. These are other materials with the exception of metals and are majorly ceramics and polymeric materials

8.2.3 Wear and Corrosion Engineering

This involves tribology and including degradation of materials due to the influence of the environment and how to mitigate the effect.

8.2.4 Mineral Processing Engineering and Extractive Metallurgical Engineering

This entails beneficiation, sintering, coking and calcination of different minerals prior to refining which is addressed by extractive metallurgy.

8.2.5 Advanced Materials Engineering

Nano Materials, Smart Materials, Composite Materials, Semi-Conductors and Bio Materials. These are sets of non-traditional materials that are employed because of their unique properties.

8.2.6 Materials Production Engineering

Foundry, Welding, Forging, Rolling, Extrusion etc. These are various processing routes for Materials.

8.3 USE OF VARIOUS EQUIPMENT IN MATERIALS AND METALLURGICAL ENGINEERING FOR VARIOUS OPERATIONS/ PROCESSES

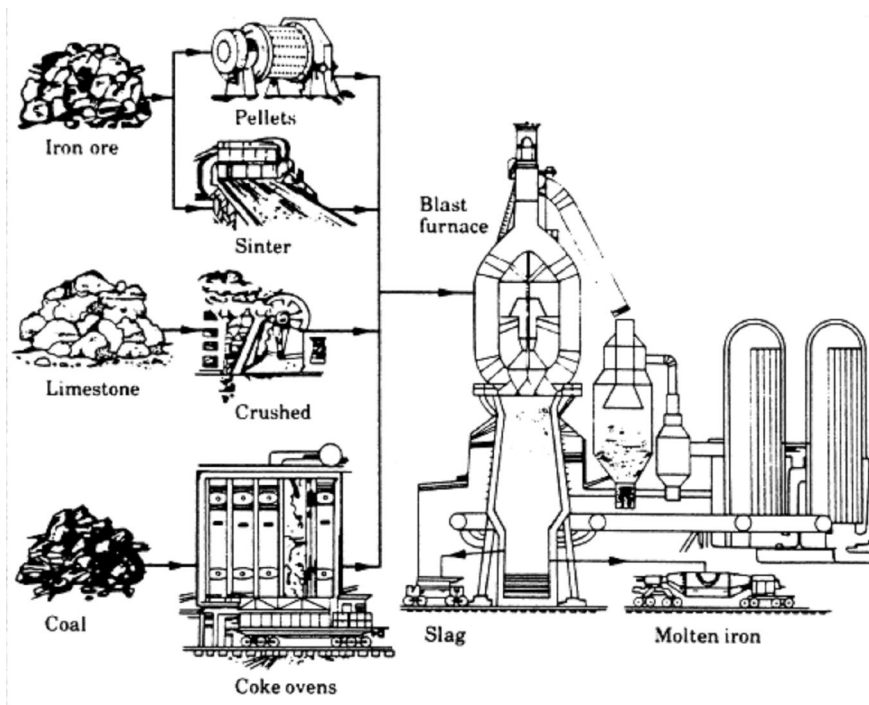
Production facilities and equipment in Materials and Metallurgical Engineering for various operations/processes:

S/NO	EQUIPMENT	APPLICATION
1	Scanning Electron Microscopy(SEM)	Materials Characterization
2	Optical Emission Spectroscopy(OES)	Sample Analysis
3	X-Ray Florescence(XRF)	Chemical Analysis of Materials
4	Universal Tensile Testing Machine(UTS)	Mechanical Properties of Materials
5	Defectoscope	Non-destructive testing of pipeline integrity

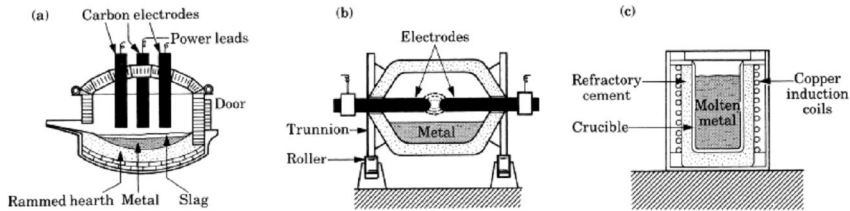
Materials processing involves refining of raw materials to produce bars and billets in melting furnaces like the blast furnace, basic oxygen furnace and electric arc furnaces for ferrous metals and alloys and eventual casting into some shapes known as billets and blooms in a continuous casting machines. Cast products must further be processed into various structural shapes in the rolling mills.

Intrinsic shapes can equally be made by direct casting of molten metal or alloys in a ready-made temporary or permanent mold that mimic the actual shape of the final products. This limit further stages of machining and hence reduces production cost quite significantly. Joining operations like welding, soldering and riveting may however be inevitable in certain situation but any choice of processing must be weighed based on the cost effectiveness. The final structure of materials and corresponding properties and performances in services may require the products to be subjected to heat treatment by heating in industrial furnace and subsequent quenching in air or in other media like brine, oil and water at a pre-determined rate to avoid distortion of shape and corrosion or other degradation. Finally other finishing operation may include electroplating to prolong the service life and protect the component from environmental hazard.

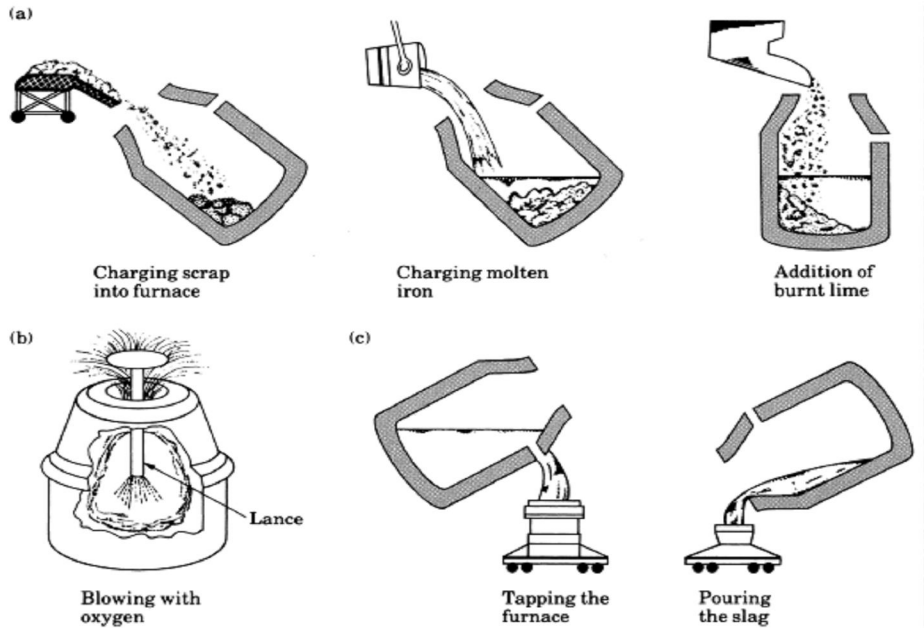
Below are some of the production facilities used to achieving the desired transformation:



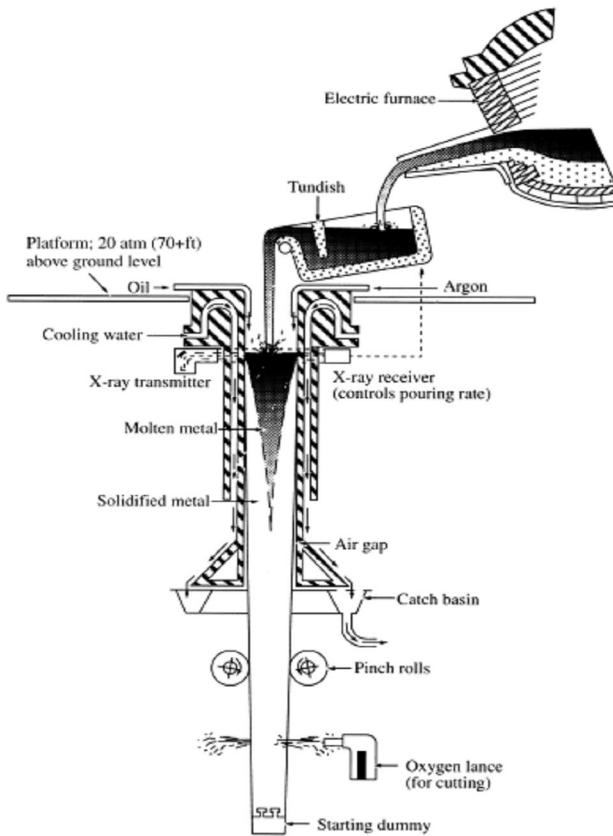
Blast Furnace: For producing pig iron



Electric Furnaces: For melting metals



Oxygen Converter: for steel production



Continuous Casting Machine (CCM): For production of billets, blooms and slabs from molten steel.

8.4. PROSPECTS AND JOB OPPORTUNITIES IN MATERIAL AND METALLURGICAL ENGINEERING

8.4.1 Process Engineers in Metallurgical and Materials Engineering Companies: They are basic involve in the design, execution and monitoring production process in metallurgical, ceramics and polymer industries.

8.4.2 Corrosion and Integrity Control Engineers in Chemical, Petrochemical, Power and Allied Industries: Many of the equipment and production facilities need to undergo regular monitoring and repair by experts in materials in those industries

8.4.3 Quality Control Engineers in Manufacturing Industry: They carry out control of quality of products coming out not only in materials and metallurgical industries but also in rolling mills, foundries and machine building industries.

8.4.4 Procurement Engineers: Materials and Metallurgical Professional are the most sort-out experts for procurement of materials both in private and public establishment.

8.4.5 Forensic Engineers: When there are sensitive things that may or may not have legal implication like collapse of structures, materials engineers are called upon to give their submission.

8.4.6 Research Institution

This helps in the development of new materials and improving the performances of existing ones and finding new areas of application for them. Higher institution of learning for advancement of knowledge in materials and their application

8.4.7 Employer of Labour

He could be as Welding Engineer, Foundry Engineer and Consultant in Corrosion and Renovation for Pipeline and Oil and Gas Storage Tanks

8.5 PROFESSIONAL BODIES IN MATERIAL AND METALLURGICAL ENGINEERING

1. Council for the regulation of Engineering in Nigeria (COREN)
2. Nigerian Society of Engineers (NSE)
3. Metallurgical, Mining and Materials Division of the Nigerian Society of Engineers
4. Nigerian Metallurgical Society (NMS)
5. Materials Society of Nigeria(MSN)
6. Nigerian Corrosion Association
7. Nigerian Association of Welding Engineers
8. American Society for Metals(ASM)
9. World Steel

8.6 THE ROLE OF MATERIAL ENGINEERS IN ADVANCEMENT OF HUMANITY.

Many modern technologies seem to work in almost magical ways. Yet, all of these technologies are based on real world science. The discoveries of scientists and engineers often allow us to create and manipulate new materials. New materials can change how we live.

1. Light-emitting diodes (LEDs) push flowing electrons across a semiconducting material. When electrons fall from a higher to a lower energy state within the semiconductor they emit photons (light). The wavelength (color) of the light is determined by the band gap (the difference between energy states) of the semiconductor. For many years, LEDs could only be manufactured with small band gaps, producing only low wavelength light (red, yellow, or green).

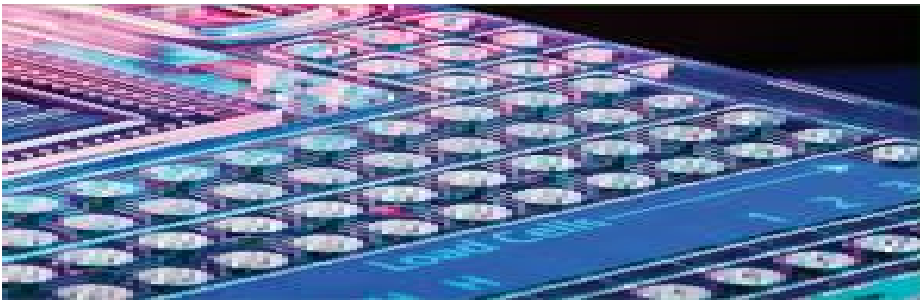


LIGHT-EMITTING DIODES (LEDs) : A long-live lightening device

What materials discovery changed this?

In 1993, the development of gallium nitride materials enabled blue and white LEDs, finally completing the LED color spectrum. Today, LED lights are longer-lived and more energy efficiency than most other types of lighting. LEDs are found in traffic lights, video screens, and everything in between.

2. Many blood tests require a vial of blood and several hours of laboratory work. Soon, doctors will be able to perform the same tests in 10 minutes using a single drop of blood and a 'lab-on-a-chip.' These devices are no bigger than a credit card, but can be designed to perform a wide range of simple, fast, and cheap medical and genetic tests.



MEDICAL LAB-ON-A-CHIP: Effective blood sample testing device

What materials discovery enables such a small device?

MICROFLUIDICS! Lab-on-a-chip technology harnesses the properties of microfluidics to manipulate and identify small molecules, like hemoglobin and DNA. Cheap medical tests could improve healthcare, especially in the world's poorest regions.

3. All batteries store energy in chemical bonds and release energy by allowing ions from those bonds to flow from a high energy state to a low energy state. Cellphones, laptops, and electric cars all require light-weight and powerful batteries that can recharge many times.



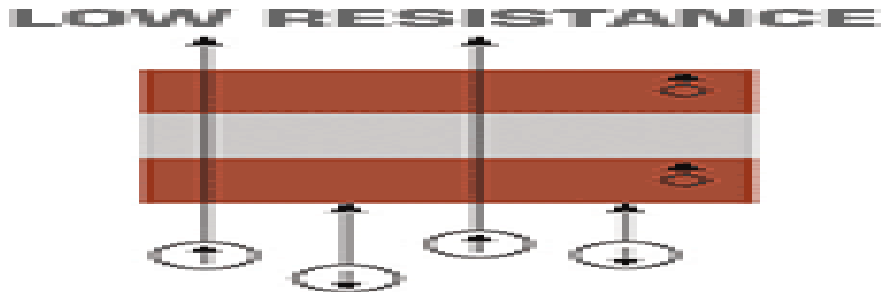
CELLPHONE BATTERIES: An energy storage device

What materials discovery enabled such a rechargeable battery?

The lithium-ion battery boasts a high energy-to-weight ratio and can hold a charge for a long time. The superior performance of these batteries is due to the crystalline structure of the materials that they're made of, which allow lithium ions to bind loosely between layers of oxygen and other elements. When the

battery is charged, the lithium ions can move easily out of the crystalline structure to other, higher energy bonds.

4. The information in computer hard drives is stored in memory bits, like tiny compass needles that can be switched between pointing north and pointing south. To increase the speed and data capacity of computer memory, computer engineers seek to make the bits smaller and more tightly packed.

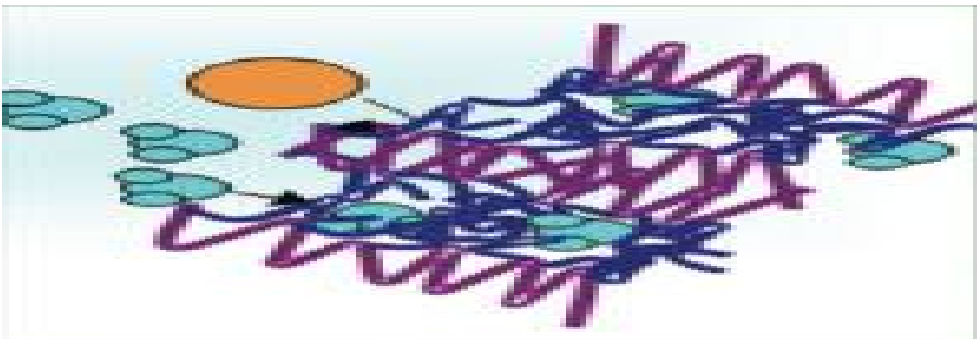


COMPUTER MEMORY: A data storage device

What materials discovery made memory bits smaller?

In special materials, the spin states of electrons can be set within a tiny area. As the image shows, by altering the spin of electrons in the top layer of a computer hard drive, the material will either conduct or block electrical current, recording binary information. The field of spintronics uses electron spin to improve electronics.

5. Production of Clean Water. 11% of the world population lacks clean drinking water.



CLEAN WATER: A Polymeric filter

What materials discovery will easily remove salt, bacteria, and dangerous chemicals from drinking water?

Membranes are used to separate water from contaminants in many methods of water filtration. However, most membranes are easily clogged and must be frequently cleaned or replaced. Researchers are designing new polymer membranes that allow water through while repelling contaminants. The diagram to the left shows how this works at a molecular level (10^{-9} meters). The dark purple polymers attract water (blue) while repelling contaminant molecules (orange). The light purple polymers provide a backbone of support.

These are just a few of the many materials discoveries that affect our lives. Future discoveries made by curious women and men-maybe by you- will undoubtedly enable new technologies and further improve our world.

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CHAPTER 9

MECHANICAL ENGINEERING DISCIPLINE

J.O. Aweda

COURSE SYNOPSIS

Mechanical Engineering

Introduction to mechanical engineering profession: Definition of mechanical engineering. Specializations/ Options in mechanical engineering. Use of various implements and equipment in mechanical engineering for various operations/process. Prospects and job opportunities in mechanical engineering as a profession. Relevant regulatory bodies and societies in mechanical engineering. The role of mechanical engineers in advancement of humanity.

9.0 INTRODUCTION TO MECHANICAL ENGINEERING DISCIPLINE

9.1 DEFINITION

Mechanical Engineering

Engineering is the profession in which knowledge of the mathematical and natural sciences 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. Mechanical engineering is the one of largest and oldest disciplines and broadest of all engineering disciplines. Mechanical engineers apply the principles of mechanics and energy to the design of machines and devices: energy and motion.

Mechanical engineering is a diverse subject that derives its breadth from the need to design and manufacture everything from small individual 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. The Mechanical Engineer needs to understand the forces and the thermal environment of a product, its parts, or its subsystems will encounter in order to design them for functionality, aesthetics, and the ability to withstand service loads and the thermal environment they will be subjected to. He determines the best way to manufacture them and ensure they will operate without failure.

Since these skills are required for virtually everything that is made, Mechanical Engineering is perhaps 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); 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); microelectromechanical systems (sensors, actuators, micropower generation); energy conversion (gas turbines, wind turbines, solar energy, fuel cells); environmental control (HVAC, air-conditioning, refrigeration, compressors); automation (robots, data and image acquisition, recognition, control); manufacturing (machining, machine tools, prototyping, microfabrication).

To put it simply, Mechanical Engineering deals with anything that moves, 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. Specialized mechanical engineering subjects include biomechanics, energy conversion, laser-assisted materials processing, combustion, microfluidic devices, fracture mechanics, nanomechanics, mechanisms, micropower generation, tribology (friction and wear), heat engineering, vibrations and many others.

The breadth of the mechanical engineering discipline allows students a variety of career options beyond some of the industries. Regardless of the particular path the students envision 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.

9.2 AREAS OF SPECIALIZATION IN MECHANICAL ENGINEERING

The following are the areas of specialization in the field of mechanical engineering:

9.2.1 Automobile / Vehicle System Engineering

An aspect of mechanical engineering is the design of vehicles. 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 manufacturable structures and systems. Alternatively fueled power systems, including electric drives, are also studied.

9.2.2 Combustion and the 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.

9.2.3 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. This 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.

9.2.4 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. Workshops have manufacturing equipment for conventional and non-traditional machining, three-dimensional measurement, and plastic injection molding. Computer-oriented manufacturing is also an emphasis of the program. A Manufacturing Engineer will have a solid background in manufacturing processes and systems as well as in statistics, design, controls, and applications of microprocessors.

9.2.5 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 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 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 and economics are other considerations.

9.2.6 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 in useful ways.

9.2.7 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.

9.2.8 Materials and Metallurgy and Processing Engineering

This area of specialization until recently has been an aspect of Mechanical Engineering. It consists of a comprehensive series of courses in metallurgy, including 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. This is the study of the behaviour of metals and composites in relation to their properties while in service.

9.2.9 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 for example, aerodynamics, internal flows with heat and mass transfer, turbomachinery and flows in the natural environment such as plumes in air and effluents in water.

9.2.10 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.

9.2.11 Welding and Joining Specialization

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.

9.2.12 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. These topics are also a prominent part of the mechanical portion of the Mechatronics Option.

9.2.13 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, in practice only a few of the options may be taken conveniently in the University of Ilorin. All of these options depend on each Institution.

9.3 USE OF VARIOUS IMPLEMENTS AND EQUIPMENT IN MECHANICAL ENGINEERING FOR VARIOUS OPERATIONS

The following are some of the implements and equipment used for various operations in Mechanical Engineering:

S/ NO	EQUIPMENT	APPLICATIONS
1	Torsion testing machine: tendency of material	used to determine the twisting
2	Impact testing machine: on the material	determines the impact of sudden load
3	Creep measuring apparatus: load required for creep to occur	determines the maximum consistent
4	Slider crank mechanism: movement of machines	determines the reciprocating
5	Whitworth quick return mechanism:	demonstrates the speed of both Working and free movement of mechanism
6	Tensometer: material	determines the tensile strength of
7	Oven:	for heat conditioning
8	Polishing machine: microstructure	for preparing of surface for examination
9	Testometric testing machine: moment tests	for compression, tensile and bending
10	Flow pipe apparatus:	determines flow pressures along the pipeline and equation of flow
11	Wind tunnel:	determines the transverse velocity profile, drag and lift forces of air

12	Smoke generator:	determines the effect of air on the various model of air flow
13	Compressible flow bench: passing through the pipe	determines the flow rate of fluid
14	Compulsed combustion:	for producing hot air for heating Purpose
15	Centrifugal force apparatus:	demonstrates and determines the magnitude of centrifugal force acting on a body
16	Gyroscope apparatus:	demonstrates the direction of gyroscopic couple and moment of inertia
17	Static and dynamic balancing:	demonstrates the static and dynamic balancing of rotating masses
18	Light and signaling demonstrator	for automobile lighting
19	Transmission simulator	for principle of transmission in automobiles
20	Suspension simulator	demonstrates suspension operation of automobile
21	Safety simulator	for automobile safety signaling in automobiles
22	ABS demonstrator	demonstrates braking system
23	Air conditioning control	demonstrates air conditioning principle
24	Ignition demonstrator	demonstrates principle of automobile ignition

9.4 PROSPECTS AND JOB OPPORTUNITIES IN MECHANICAL ENGINEERING

Mechanical Engineer: Job description

The diverse mechanical engineering field can be divided in 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:

9.4.1 Product Design -- developing products ranging from biomedical devices to gasoline-powered engines. A mechanical engineer designs anything that uses mechanical motion.

9.4.2 Research and Development -- discovering new solutions to human needs or improving older methods

9.4.3 Manufacturing -- developing the machines that process materials into products. Designing and building machines and systems of machines that improve operating efficiency is of prime importance

9.4.4 Systems Management -- overseeing operations of a large system, such as a power plant, as well as supervising the people who work there.

9.4.5 Energy -- planning how energy is generated, stored, and moved. Industries that produce and deliver electrical power, such as natural gas, oil and alternative energy, employ mechanical engineers to develop more fuel-efficient cars, motors, and appliances.

9.4.6 Financial Institutions -- as equipment maintenance and initiating small scale businesses

9.4.7 Government Agencies -- as maintenance and technical officers in charge of utility equipment and construction of new ones. Engineers also serve as planners for the implementation of government policies

9.4.8 Researchers -- in higher or specialized research Institutes

9.4.9 Consultancy Services -- as private consultant or in an organized firm

9.5 RELEVANT PROFESSIONAL BODIES IN MECHANICAL ENGINEERING

There are many Professional bodies Mechanical Engineer can belong. These are local and international Professional bodies. Among these are,

- i. Council for the Regulation of Engineering in Nigeria, (COREN)
- ii. The Nigerian Society of Engineers, (NSE)
- iii. Nigerian Institution of Mechanical Engineers, (NIMechE)
- iv. Industrial Engineering Division of NSE
- v. Automobile Engineers Institute,
- vi. Petroleum Division of NSE
- vii. Institute of Appraisal and Cost Engineering, Division of NSE
- viii. Engineering Institute of Canada
- ix. Canadian Nuclear Society
- x. American Society of Mechanical Engineers, (ASME)
- xi. Institution of Engineers India
- xii. European Federation of National Engineering Association

9.6 ROLE OF MECHANICAL ENGINEERS IN THE ADVANCEMENT OF HUMANITY

Mechanical Engineers contribute to the development of the nation and his immediate environment in diverse ways which include:

- i. Development and production of equipment for small and medium entrepreneurs
- ii. Research and development of new equipment for improved productivity
- iii. Standardization of equipment produced locally or imported into the country
- iv. Undertake research into man-machine relationship with the objective of improving human comfort
- v. Formulation of appropriate standard in Mechanical Engineering adaptable to the country for ease of operation and maintenance of such equipment

- vi. Research into the local content in the areas of material usage and development

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CHAPTER 10

WATER RESOURCES AND ENVIRONMENTAL ENGINEERING DISCIPLINE

A.S. Aremu

COURSE SYNOPSIS

Mechanical Engineering

Introduction to water resources and environmental engineering profession: Definition of water resources and environmental engineering. Specializations/ Options in water resources and environmental engineering. Use of various implements and equipment in water resources and environmental engineering for various operations/process. Prospects and job opportunities in water resources and environmental engineering as a profession. Relevant regulatory bodies and societies in water resources and environmental engineering. The role of water resources and environmental engineers in advancement of humanity.

10.0 INTRODUCTION TO WATER RESOURCES AND ENVIRONMENTAL ENGINEERING DISCIPLINE

10.1 DEFINITION

Water and several environmental problems are among the topmost emerging issues that have local, national and global importance. Water typifies the liquid state of matter and it is one of the most vital natural resources for sustenance of life on earth. It is an abundant natural resource distinctively occupying 75% of the earth surface and equally occupying 50-90% of the weight of living organisms. The main uses of water include application in various domestic, spiritual or cultural, commercial and industrial activities; transportation; agriculture; livelihood; recreation and tourism; energy generation; and firefighting. Water resources are potential sources of water for use and they include surface waters (lakes, rivers, and streams) and groundwater (water beneath the earth's surface). Environment is the sum total of man's surroundings and it includes natural forces and other living things, which provide conditions for development and growth as well as avenues of danger and damage. The natural environment encompasses all living and non-living things occurring naturally on earth. However, when humans modify the natural environment for specific needs, the environment becomes man-made or "built environment". This continuous modification of the natural

environment in addition to expanding global population, presents several challenges to man and the environment.

The world's water resources and environment are continuously witnessing tremendous pressure from all angles; hence there is need for trained engineers with specialty in Water Resources and Environmental Engineering. Though Water Resources and Environmental Engineering have long been two distinct specialist fields in Civil Engineering, the evolution of several water, sanitation and environmental challenges necessitates taking up new skills, capabilities, perspectives and more importantly a "focused" approach to tackle these problems.

Water Resources and Environmental Engineering is the branch of engineering concerned with prediction, planning, development and management of water resources and application of engineering principles to improve and protect the environment. Hence, Water Resources and Environmental Engineers combine knowledge of physical and biological sciences with engineering to solve problems related to unfavorable natural phenomena, population growth, industrialization and urbanization. Such problems include earth quakes, tsunamis, tornado, flood, draught, water provision, air and water pollution, sanitation, public health, wastewater, solid wastes, and hazardous wastes management.

10.2 AREAS OF SPECIALIZATION IN WATER RESOURCES AND ENVIRONMENTAL ENGINEERING

Water Resources and Environmental Engineering discipline provides two primary areas of specialization; Water Resources Engineering or Environmental Engineering. However there are numerous options within each area of specialization.

10.2.1 Water Resources Engineering

This is the sub-discipline concerned with planning, developing, managing water, sewage or any other fluid. Research options in Water Resources Engineering include hydraulics, hydrology (surface water, groundwater and marine hydrology), coastal engineering, erosion and flood control, reservoir operation and management, irrigation and drainage, and water supply.

10.2.2 Environmental Engineering

This is an area of specialization concerned with assessing, regulating and managing the effects of human and other activities on both natural and built environment. The overall focus is protection and preservation of the environment.

Research options available in Environmental Engineering include sanitation, air pollution control, air, soil and water remediation, hazardous waste treatment and disposal, wastewater management, solid waste engineering and management, and green engineering.

10.3 SOME EQUIPMENT USED IN WATER RESOURCES AND ENVIRONMENTAL ENGINEERING

The following are some of the equipment used for various operations in Water Resources and Environmental Engineering::

S/No	Equipment	Uses
1.	pH Meter	to determine the alkalinity and acidity of water
2.	Incubator	screening of algae and some other suspended solids in water treatment.
3.	Oven	drying and sterilization of samples
4.	Gas monitor/detector	measuring gaseous air pollutants and particulate matter
5.	Spectrophotometer	testing water quality- qualitative determination of chemical elements in water
6.	Gas Chromatograph	separating a substance or chemicals from a complex sample
7.	Bomb calorimeter	measuring the energy released in a combustion reaction
8.	Hydrokinetics System	to study flow of fluid through closed conduits and open channels
9.	Fluid Friction Apparatus	for determination of fluid friction through pipes
10.	Turbidimeter	measurement of relative clarity of fluids (turbidity)

11.	Flow meter	to measure flow rate or quantity of a gas or liquid in a pipe
12.	Sound level meter	measure sound pressure level/ noise
13.	Capillarity tube	measurement of capillary elevation
14.	Thermometer	measurement of temperature
15.	Rain guage	measure the amount of rainfall or precipitation at a specific place over a particular period of time

10.4 PROSPECTS AND JOB OPPORTUNITIES IN WATER RESOURCES AND ENVIRONMENTAL ENGINEERING

Water Resources and Environmental Engineering encompasses a wide range of disciplines, all of which in some way relate to the provision of the essential services and/or facilities. There is great prospect in pursuing a career in Water Resources and Environmental Engineering. Severe water and environmental problems which need professionalism to subtle gave rise to Water Resources and Environmental Engineering as a distinct discipline. With economic and population growth, there will be a constant demand for Water Resources and Environmental Engineers who can plan and design water and environmental engineering systems.

Water Resources and Environmental Engineering graduates have strong employment opportunities in many sectors of Nigeria and Intergovernmental organizations. In Nigeria, they are employed by intergovernmental, governmental, and non-governmental agencies at local, state and federal levels. Generally employment opportunities for Water Resources and Environmental Engineering graduates are available in the following areas:

10.4.1 Industries/Companies – i.e beverages, water producing, oil and gas, chemical, telecommunication, textile, construction, pharmaceutical, soap & cosmetics, and conglomerates

10.4.2 Federal/State Ministries - i.e. Water Resources & Rural Development, Environment, Agriculture and Natural Resources, Petroleum Resources, Works and Housing , Health and Social Services, Science and Technology.

10.4.3 Agencies & Parastatals – i.e. Nigerian Integrated Water Resources Commission, National Environmental Standards and Regulations Enforcement Agency, River Basin Authorities, Development / Energy Commissions, Water Boards/Corporations, National Maritime Authority, Department of Petroleum Resources, Directorate of Food, Roads & Rural Infrastructures, Department of Fisheries, Federal/State Environmental Protection Agencies, National Agricultural Land Development Authority, National Resources Conservation Council, Standard Organization of Nigeria, and National Emergency Management Agency.

10.4.4 Research Institutes/Institutions – i.e Universities, polytechnics, National Water Resources Institute, Lake Chad Research Institute, Nigeria institute for Oceanography and Marine Research, National Institute for Fresh Water Fisheries Research, International institute for Tropical Agriculture.

10.4.5 International Organizations - i.e. United Nations Environment Programme (UNEP), World Health Organization (WHO), United Nations Development Programme (UNDP), United Nations Children’s Fund (UNICEF), Food & Agriculture Organization (FAO), United Nations Education Science and Cultural Organization (UNESCO), Economic Community of West African States (ECOWAS), African Union (AU), Intergovernmental Panel on Climate Change (IPCC), International Bank for Reconstruction and Development (IBRD), WaterAid.

10.4.6 Engagement in service provision - drilling, solid waste and wastewater disposal, clean ups and remediation/reclamation, field studies, project management, construction, advisory and consulting services, supply and installation, dredging, equipment maintenance, environmental audit and impact assessment, and various integrated and customized services.

10.4.7 Manufacturing & production – Sanitary ware/ fixtures/fittings, pipe, conduits manufacturing, small scale and industrial water or beverage production, design and production of water treatment facilities, industrial pumps, valves, mobile toilets, recycling of wastes, air distribution and environmental control systems.

10.4.8 Miscellaneous Employment - i.e. Private firms, consultancy firms, non-Governmental Organizations, part-time supervisory role for sponsored projects, community educators/ instructors/ resource persons, short service course in the

military, appointment into professional/regulatory bodies, boards, and commissions, political appointments.

In all, employers require that a Water Resources and Environmental Engineering practitioner has at least a Bachelor's degree in Water Resources and Environmental Engineering. However, as the engineering graduate progresses in this career, he/she will be required to register with Nigeria Society of Engineers (NSE) and Council for the Regulation of Engineering in Nigeria (COREN). To teach in a Polytechnic, a Bachelor's degree with a minimum of 2nd class lower division is required while to begin a career as an academic in the University, a Bachelor's degree with a minimum of 2nd Class Upper Division is a prerequisite. According to the United States Bureau of Labour Statistics, the employment opportunities for Water Resources and Environmental Engineers are predicted to grow faster than the average growth rate of other occupations in the period through 2014.

10.5 RELEVANT PROFESSIONAL BODIES IN WATER RESOURCES AND ENVIRONMENTAL ENGINEERING

(i) Regulatory Agency

The primary regulatory agency for Water Resources and Environmental Engineering and other engineering disciplines in Nigeria is the Council for the Regulation of Engineering in Nigeria (COREN). The Council was set up by the Decrees 55/70 and 27/92 (now Acts 110).

(ii) Nigeria Society of Engineers (NSE) - The Nigerian Society of Engineers is the umbrella organization for the Engineering profession in Nigeria. The divisions in NSE relevant to Water Resources and Environmental Engineering are (i) Water Division (ii) Environment Division (iii) Marine Engineering & Naval Architecture Division. Categories of membership- Student Member, Graduate Member, Corporate Member, and Fellow.

(iii) Association for Environmental Impact Assessment of Nigeria (AEIAN) - The Association for Environmental Impact Assessment of Nigeria (AEIAN), incorporated on 27th September 2010, is the umbrella body of Nigerian members of the International Association for Impact Assessment (IAIA).

(iv) The Nigerian Meteorological Society (NMetS): NMetS is a forum for scholars, scientists, researchers and stakeholders to promote the ideals of climate science in order to guarantee the safety and well-being of the people, reduce poverty and protect; and improve the environment of Nigeria and the rest of the

world for future generations. Membership levels available for Water Resources and Environmental Engineers are Associate, Corporate and Fellow.

(v) Nigerian Environmental Society (NES): The Nigerian Environmental Society is a professional organization which is committed to the protection, development and sustenance of the environment and to the promotion of the profession of Environmental Science and Engineering both in theory and practice.

(vi) Nigerian Water Supply Association (NWSA): The Association was set as a professional body with a mission to up-lift man and the environment through improved water supply and sanitation in Nigeria.

(vii) Water Environment Federation (WEF): The Water Environment Federation was founded in 1928 and it is a technical and educational organization of individual members and affiliated member associations representing water quality professionals around the world. Membership options for individuals from Nigeria are: (i) WEF Global Professional Membership - Low Income Country and (ii) e-Global Professional Membership.

(viii) International Solid Wastes Association (ISWA): The mission of ISWA is to promote and develop sustainable and professional waste management worldwide. National and individual membership is available to Water Resources and Environmental Engineering practitioners.

(ix) The International Water Association (IWA): The mission of the association is to serve as a worldwide network for water professionals and to promote standards and best practices in sustainable water management. The association has four member types for Water Resources and Environmental Engineering students/graduates: individual, student, corporate, and governing members.

10.6 ROLE OF WATER RESOURCES AND ENVIRONMENTAL ENGINEERS IN THE ADVANCEMENT OF HUMANITY

Water Resources and Environmental Engineering encompasses a wide range of duties, all of which relate to the environmental protection and provision of the essential services. The critical roles water resources and environmental engineers play in the advancement of humanity are as follows:

- (i) Planning, analysis, design, construction and operation of projects for the control, utilization, and management of water-dependent ecosystems
- (ii) Development and management of systems for storing and providing water for cities, irrigated farms, industrial use, hydroelectric-power generation and other beneficial uses
- (iii) Developing cleaner and more sustainable energy sources and “green” (renewable) materials
- (iv) Management of wastewater and sewage
- (v) Design of sanitation facilities for safe collection and disposal of excreta
- (vi) Collection and disposal of by-products of human activities (wastes) and dispose them in an environmental friendly manner
- (vii) Design projects such as water reclamation facilities, air pollution control systems, and operations that convert waste to energy
- (viii) Addressing the world’s challenges of air, land and water pollution, climate change, and global warming
- (ix) Management of hazardous waste
- (x) Management and design of noise abatement strategies
- (xi) Preventing and controlling flood or soil erosion from damages that may occur
- (xii) Setting of environmental standards and regulation to protect all living things and the natural environment
- (xiii) Cleaning up pollution and locating sites for safe disposal of hazardous wastes
- (xiv) Developing technical guidance materials and regulations, and continuous review of legislations regarding water and the environment
- (xv) Provision of technical assistance to water system operators, design consultants, municipal boards and the general public
- (xvi) Management of assets/ facilities for treatment, supply and distribution of water or any other liquid
- (xvii) Carrying out environmental impact assessment before the execution of a proposed project so as to predetermine the associated environmental or health risks and proffer mitigation methods

- (xviii) Carrying out research to address new challenges and problems that may be caused by population growth, global warming, over-utilization of natural resources, and pollution

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