ISSN: 2641-2039
Global Journal of Engineering Sciences
DOI: 10.33552/GJES.2022.09.000716
Iris Publishers

Research Article

A Review Study on the Syllabuses of the Mechanical Engineering College Atbara New Diploma Course for Second Year

Osama Mohammed Elmardi Suleiman Khayal*

Associate Professor, Department of Mechanical Engineering, Faculty of Engineering and Technology, Nile Valley University, Atbara, Sudan

***Corresponding author:** Osama Mohammed Elmardi Suleiman Khayal, Associate Professor, Department of Mechanical Engineering, Faculty of Engineering and Technology, Nile Valley University, Atbara, Sudan.

Received Date: April 14, 2022

Published Date: April 22, 2022

Abstract

Mechanical engineering is one of the most diverse and versatile engineering fields. Mechanical engineering is the study of objects and systems in motion and static states. As such, the field of mechanical engineering touches virtually every aspect of modern life, including the human body, which is a highly complex machine.

The role of a mechanical engineer is to take a product from an idea to the marketplace. To accomplish this, the mechanical engineer must be able to determine the forces and thermal environment that a product, its parts, or its subsystems will encounter; design them for functionality, aesthetics, and durability; and determine the best manufacturing approach that will ensure operation without failure.

Mechanical engineers play key roles in a wide range of industries including automotive, aerospace, biotechnology, computers, electronics, microelectromechanical systems, energy conversion, robotics and automation, and manufacturing.

The breadth of the mechanical engineering discipline allows students a variety of career options beyond the industries listed above. Regardless of the particular path, they envision for themselves, a mechanical engineering education empowers students with creative thinking skills to design an exciting product or system; analytical tools to achieve their design goals; the ability to overcome all constraints; and the teamwork needed to design, market, and produce a system. These valuable skills can be applied to launch careers in many other fields, such as medicine, law, consulting, management, banking, and finance.

It is believed that through this applications approach, the student technician will develop a practical working knowledge, which is a very necessary adjunct to the needs of industry within the country.

The choice of appropriate subjects reflects the national needs as they are observed at present, but attention is also paid to the future.

Keywords: Mechanical engineering; Power and manufacturing options; Syllabuses; Subject Content; Aims; Second year diploma of MECA

Introduction

Mechanical engineering is now part of our world and allowing us to develop new outstanding mechanical systems to optimize research and production. However, it has changed and evolved, to be where it is now.

Degrees in mechanical engineering are offered at various universities worldwide. Mechanical engineering programs typically take four to five years of study depending on the place and university and result in a Bachelor of Engineering (B.Eng. or B.E.), Bachelor of Science (B.Sc. or B.S.), Bachelor of Science Engineering (B.Sc. Eng.), Bachelor of Technology (B.Tech.), Bachelor of Mechanical Engineering (B.M.E.), or Bachelor of Applied Science (B.A.Sc.) degree, in or with emphasis in mechanical engineering. In Spain, Portugal and most of South America, where neither B.S. nor B.Tech. Programs have been adopted, the formal name for the degree is "Mechanical Engineer", and the course work is based on five or six years of training. In Italy the course work is based on five years of education, and training, but in order to qualify as an Engineer one has to pass a state exam at the end of the course. In Greece, the coursework is based on a five-year curriculum and the requirement of a 'Diploma' Thesis, which upon completion a 'Diploma' is awarded rather than a B.Sc.

Most mechanical engineering programs also require varying amounts of research or community projects to gain practical problem - solving experience. In the United States, it is common for mechanical engineering students to complete one or more internships (training periods) while studying, though this is not typically mandated by the university. Cooperative education is another option. Future work skills and research puts demand on study components that feed student's creativity and innovation.

The Mechanical Engineering College Atbara has offered a 3-years course in mechanical engineering since 1971. This current course is a logical development of the previous course, and maintains as its overall objective, the education of technician engineers to a level of practical and academic competence compatible with that of Western Europe and satisfying the particular needs of the Sudan.

The course is of three years duration and leads to the award of a diploma in mechanical engineering. It is designed for full time study inclusive of academic study, practical instruction and industrial training. The first two years are common and contain basic mechanical and production engineering subjects. In the final year, students select either the mechanical engineering (Power option) or production engineering (Technology and Systems option).

Admission to the course is by either selection from holders of the academic or technical Sudan school certificate with credit levels in mathematics, physics and an appropriate science subject; or mathematics, engineering drawing and workshop technology.

The institute was established in 1971 under the name " Institute of Mechanical Engineering Technicians" (IMET), with the main objective of supplying the country with high level engineering technicians, who can effectively contribute to the industrial development and to the increasing demand for mechanical engineering technicians.

In 1976 the IMET was renamed as "Mechanical Engineering College Atbara "(MECA), and it continued to award Engineering Diploma of 3-years duration in mechanical engineering , in power and production options.

In 1990 the Nile valley University, (NVU), was established and (MECA) became one of the faculties of the university and it was renamed as " Faculty of Engineering & Technology (FET).

The following matter covers the subjects' content of the first year of the diploma course in mechanical engineering.

The course has been designed primarily to meet the growing needs for technician engineers in the Sudan. This need is recognized to be manifested currently in two areas; firstly, in the development and provision of national infrastructure of power, transport, communications and other development schemes, and secondly in the growth of engineering service and general manufacturing industries.

In the former, particular attention is paid to the education of the student as a mechanical engineering technician seeking in a career typically within power generation, road and rail transport, irrigation schemes and the sugar industry. To this end subject matter essential to the general base of engineering knowledge has been combined with that more specifically related to mechanical engineering within the industries concerned.

Similarly, the student as a production engineer will build upon the foundation studies of years one and two, and will in the final year, study the elements of production engineering which make for a competitive and efficient manufacturing industry; namely, the technology of production and the organization of production systems.

In designing the curriculum, the subject material in the final year has been related directly to the detailed objectives of the graduate technician engineer and from these, specific aims for each subject have been produced. Years 1 and 2 have been designed with these aims clearly in view.

The course is essentially practical in nature with some 40% of the curriculum being devoted to projects, workshop practice and integrative studies, and it is the intention to teach theory from an applications point of view.

The main objective of the new course is to produce both mechanical and production technician engineers who are capable of working, typically in a supervisory capacity within all branches of the engineering service and manufacturing industry of Sudan.

The emphasis is on the broader aspects of engineering technician education, rather than on the highly specialized, in recognition of the diversification likely within future careers of the MECA graduates [1-38].

Figure 1 below shows the main gate of the Faculty of Engineering and Technology – Atbara and Figure 2 below shows the logo of the festival of golden jubilee of mechanical engineering college Atbara (MECA).

Subject's Aims and Contents of the Second Year

The following matter covers the subjects' content of the second year of the diploma course in mechanical engineering.

Thermodynamics II (45 hours)

The overall aims of thermodynamics II are as follows:

To further widen the students understanding of the principles governing various heat engines and to present an in-depth appreciation of common thermodynamic plant.

Figure 1: Photo Showing the Main Gate of the Faculty of Engineering and Technology – Atbara.

Figure 2: The Logo of the Festival of Golden Jubilee of Mechanical Engineering College Atbara (MECA).

Second Law of Thermodynamics (8 hours): The aims are to introduce the second law as far as it is required for an understanding of the principles underlying the achievement of high thermal efficiency (Carnot) and to enable the student to be able to use isentropic efficiencies in the final year of study.

a. Subject matter:

- Clausius statement of second law, reversibility, and entropy defined as the ratio of energy quantity to energy level, entropy change, and mathematical definition. Flow process representation on T – S, H – S, diagrams.
- Isentropic efficiency. Principles for maximum thermal efficiency, Carnot.

Internal Combustion Engines (18 hours): The aims are to appreciate the components, and to analyze their ideal thermodynamic cycles.

b. Subject Matter:

- Description of S.I. and C.I. Engines.
- Operation and control of 4 stroke and 2 strokes S.I. engines, carburation, fuel injection, ignition timing.
- Operation and control of 4 stroke and 2 stroke C.I. engines, injection systems. Air standard cycles; constant volume cycle; constant pressure cycle; dual combustion cycle, determination of net work done, cycle thermal efficiency in terms of heat and work and in terms of compression ratio.

- Comparison of theoretical and actual cycles

Air Compressors (8 hours):

The aims are to enable the student to understand the practical and theoretical principles of operation of a variety of compressor types.

c. Subject Matter:

- Reciprocating compressors; single stage cycle, work input, volumetric and isothermal efficiencies. Multistage compression, condition for minimum work, intercooling, after cooling.
- Rotary compressors; descriptive treatment of positive displacement types, centrifugal and axial flow compressors and fans.
- Application of steady flow energy equation.

Psychrometry (11 hours): The aim is to provide an understanding of the principles used to determine the properties of air – vapor mixtures.

d. Subject matter:

- Basic Psychrometry; dew point, specific and relative humidity, wet and dry bulb temperatures, psychrometers, enthalpy of psychrometric mixtures.
- Use of psychrometric chart and tables.
- Processes involving psychrometric mixtures; analysis of heating or cooling processes, humidification and dehumidification, mixing processes, cooling towers, complete air conditioning systems.

References:

1. Thermodynamics and Transport Properties of Fluids, S.I. units. Y.R. Mayhew and G.F.C. Rogers, pub: Basil Blackwell.
2. Enthalpy – entropy diagram for steam. D.C. Hickson and F.R. Taylor, pub: Basil Blackwell.
3. Applied Thermodynamics for Engineering Technologists, By T.D. Eastop and A. McConkey. Pub: Longman.
4. Engineering Thermodynamics, Work and Heat Transfer, G.F.C. Rogers and Y.R. Mayhew. Pub: Longman.
5. Thermodynamics, K. Work. Pub: McGraw Hill.
6. Heat Transfer, F.M. White. Pub: Addison Wesley.
7. Heat Transfer, R. Joel. Pub: Longmans.
8. Heat Transfer Engineering, H. Schenck. Pub: Longmans.

Fluid Mechanics II (45 hours)

The overall aims of fluid mechanics II are as follows:

To widen the student's knowledge in the field of static fluids. By the end of this year the student should have a detailed understanding of forces acting on bodies in contact with fluids.

The student should also have a working knowledge of incompressible flow in pipes and the analysis of water supply and demand.

It is also required that the student should have a basic understanding of the technology of various fluid machinery.

Hydrostatics and Buoyancy (8 hours): The aim is to analyze the nature and effect of forces exerted on partially and totally submerged bodies.

a. Subject matter:

- Hydrostatic thrust on plane, vertical and inclined surfaces; center of pressure, thrust on curved surfaces. Application to dams and gates.
- Equilibrium of floating bodies, Archimedes principle, center of buoyancy, metacenter and metacentric heights.

Liquids in Relative Equilibrium (6 hours): The aim is to examine and understand the nature and effect of forces exerted by fluids contained in moving vessels on the vessel.

b. Subject matter:

- Flow in a curved path.
- Liquids subjected to translatory motion free and forced vortices.

Pipe Flow and Power Transmission (15 hours): The aim is to enable simple pipework and power transmission systems to be understood and analyzed.

c. Subject matter:

- Pipe flow; effect of surface roughness, determination of friction factors and energy losses in pipework and fittings using graphical and tabulated data.
- Pipe networks; series and parallel arrangements, velocity distribution. Power transmission; efficiency, variations of power due to discharge rate, conditions for maximum power transmission, effects of nozzle size.

Storage Reservoirs (8 hours): The aim is to provide an understanding of water supply and demand problems.

d. Subject matter:

- Methods of presenting supply and demand data, mass flow curves, hydrograph tabulation.
- Flow under varying head; time required for emptying and filling tanks and reservoirs.
- Losses from open channels and reservoirs; evaporative losses, substrate losses.

Fluid Machinery (8 hours): The aim is to provide a practical understanding of components and the operation of pumps and turbines.

e. Subject matter:

- Definitions and descriptions of positive displacement and rotodynamic machines; types of pumps, centrifugal, axial, reciprocating; types of turbines, the pelton wheel, Francis turbine, axial flow turbine.
- The concept of performance characteristics.

- Operational aspects; effect of speed and size of pump, nature of liquid pipe circuit, cavitation, age and wear.

References

1. Fluid Mechanics by Massey.
2. Fluid Mechanics by Douglas gariosek et al.
3. Mechanics of Fluids by A.C. Walshaw and D.A. Jobson. Pub: Longmans.
4. Hydraulics and Fluid Mechanics by E .H. Lewitt. Pub: Pitmans.
5. Fluid Mechanics by R.L. Daugherty and A.C. Ingersoll. Pub: ISE.
6. Fluid Mechanics by V.L. Steeter. Pub: McGraw Hill.

Electrical Technology II (60 hours)

The overall aims of electrical technology II are as follows:

To develop a further understanding of electrical science and engineering, with particular emphasis on electrical machines and control equipment.

Three Phase Supplies and Associated circuitry (10 hours): The aim is to give the student an understanding of the basic principles and practice concerned with 3 phase STAR and DELTA connected systems.

a. Subject matter:

- Phasor diagram applied to 3 phase voltages and trigonometric relationships.
- Relationships between line and phase voltages and currents in STAR and DELTA connected systems.
- Power in 3 phase STAR and DELTA systems with balanced loads.
- Wattmeter method of power measurements and power factor.
- Dangers of neutral earthing/unbalanced loads.

Electrical Rotating Machines (17 hours): The aim is to introduce the student to theoretical and practical concepts associated with DC and AC generators/motors.

b. Subject matter:

- Equations of performance for dc/shunt, series and compound generators and motors. Equations of the type E=KØn, T=KØIa, V=E+IaRa.
- Mechanical construction and electrical connections of dc machines.
- Methods of improving commutation, interpoles, manual speed control of machines, use of series and diverter resistors.
- Safety precautions – dangers of using series connected motor with light load.
- Braking methods – eddy current, mechanical methods.
- Uses of dc motors in industrial applications e.g. lifting gear, conveyors, etc.
- Mechanical construction of 3 phase induction motor with cage or wound rotor. Equation of performance of induction motor to include slip, speed, torque, power, power factor, efficiency.
- Characteristic curves. Energy losses associated with all types of electric motor. Simple calculations based on speed, slip, torque, efficiency. Applications of 3 phase motors and advantages of dc motors. Applications of 3 phase generator, to include mechanical construction, electrical connections.

Control of Electrical Power, Electrical Machines (15 hours): The aim is to give an appreciation of control and installation of electrical machines with particular emphasis on speed control.

c. Subject matter:

- Installation of dc motors, connections to armature and field, earthing. Need for starting resistance when under manual control.
- Measurement of input and output power.
- Installation of AC motors (3 phase), connections to stator.
- Connections to rotor for synchronous machine.
- Phase rotation and checks with phase rotation meter.
- Star/delta starting, online starting.
- Measurement of input and output power. Speed control of dc motors, manual using variable resistors in field and armature circuits.
- Speed control of 3 ph induction machines, pole changing.
- Appreciation of thyristor and its application in controllable rectification.
- Use of thyristor in electronic speed control of dc machines.

Electronics (12 hours): The aims are to introduce the student to discrete electronic components and some of their applications in mechanical/production engineering.

d. Subject matter:

- Active/passive components, color-coding of components (European), diodes – function and zener.
- Application of zener diode in voltage stabilization.
- Silicon NPN transistor. Transistor performance when used as a solid-state switch.
- Testing components to identify faults in circuitry e.g. short circuit junctions. Understanding circuit diagrams, literature and manufacturers data sheets.

Industrial Electronics (6 hours): The aim is to give the student an appreciation of power control devices and electronics associated with control of machines.

e. Subject matter:

- Switching relays, including pole changeover for reversing polarity.

- Coil and contact ratings, operation via silicon transistor.
- Solid state relays for switching ac loads.
- Problems associated with, contact bounce, sticking contact.
- Use of solenoids, checking for correct operation.
- Linear IC amplifiers for comparison, summing, and inverting/non inverting amplification.
- Transistors, NPN/PNP types.
- Power transistors and their use in control devices.

References

1. Electrical Technology, by Edward Hughes. Pub: Longmans.
2. Study Notes for Technicians, Electrical and Electronic Principles, Vol. 3, by J.B. Pratley. Pub: McGraw Hill.
3. A practical Introduction to Electronic Circuits, by M.H. Jones. Pub: Cambridge University Press.
4. Industrial Electronics, by N. Morris. Pub: McGraw Hill.
5. Foundation Electronics, by Barker.

Properties of Materials II (50 hours)

The overall aims of properties of materials II are as follows:

To continue to develop an understanding of materials commonly found in manufactured components, with particular reference to the criteria for design.

Ferrous Alloys (10 hours): The aim is to describe the iron – carbon diagram, explaining the effect of percentage carbon on the mechanical properties of carbon steel and heat treatment processes.

a. Subject matter:

- The Fe/C equilibrium diagram, effect of C on mechanical properties.
- Normalizing and annealing.
- Cooling rates and the effect on hardness.
- Furnace atmosphere and the heating of steel.

Steels (8 hours): The aim is to understand the effects of adding elements to plain carbon steels and to relate alloying to hardenability.

Plain carbon steel and alloying; properties and applications.

Isothermal transformation for plain carbon and alloy steels; quenching.

Jominy and quench test and its use.

Heat treatment; annealing, spherodising, nitriding, carburizing, flame hardening, austempering.

Cast Irons (5 hours): The aim is to be able to describe the structure, properties and applications of common cast iron.

A full description of the Fe/C diagram and using it to consider the structure and heat treatment of steels.

Description of isothermal transformation curves for different alloy steels and using them to determine the heat treatment processes.

Consideration of hardenability of steel alloys.

Description and application of various cast irons.

Non - Ferrous Alloys (6 hours): The aim is to have a knowledge of non – ferrous alloys and relate them to their applications.

a. Subject Matter: A description of the structure of non – ferrous metals and alloys and the particular properties, which make them attractive to the design engineer.

Polymers (11 hours): The aim is to have a knowledge of the structure and properties of polymeric materials.

b. Subject matter:

- Description of the structure and properties of thermoplastic, thermosetting, polymers and elastomers. Modification of polymers by the use of additives and copolymerization.

Ceramics (5 hours): The aims are to have an outline of the structure and properties of ceramics.

c. Subject matter: A brief description of the structure and properties of ceramic materials.

Composite Materials (5 hours): The aims are to have a knowledge of what a composite is, how the structure is built up and the relation of fiber direction to properties.

d. Subject matter:

- A description of typical composite materials such as glass, reinforced plastics and carbon fiber reinforced materials.
- The theory of fiber reinforcement and the effect of fiber angle on the properties of the composite.
- Applications of typical composite materials.

References:

1. Materials science for engineers, Van Vlack L.C., pub: Addison – Wesley 1980.
2. Engineering Materials, Ashby M.F., Jones D.R.H., and pub: Pergamon 1980.
3. Metallurgy for Engineers, Rollason E.C., pub: Arnold 1973.

Strength of Materials II (50 hours)

The overall aims of strength of materials II are as follows:

To develop an analytical approach to the solution of problems associated with deformation of materials.

To give the student an introduction to stress/strain analysis and to identify both 3 dimensional and 2-dimensional stress systems and analyze the latter.

Simple Bending of Beams (10 hours): The aim is to develop and use the theory of simple bending of symmetrical and unsymmetrical beams.

a. Subject matter: Definition of simple bending, assumptions involved in the theory of simple bending, stress distribution, position of neutral axis, moment of resistance, moduli of section, application of the bending equation, combined bending and direct stress, elastic strain energy of bending.

Torsion of Circular Shafts (8 hours): The aim is to develop the theory of torsion of circular section bars.

b. Subject matter: Assumptions involved in the theory of torsion, stress distribution in solid and hollow shafts, moment of resistance to twisting, polar second moment of area, strain energy in torsion, power transmission by shafts, application of torsion equation, combined bending and torsion, strain energy due to torsion.

Axial Stress in Unsymmetrical Loading (12 hours): The aim is to develop the theory for axial stresses in beams and apply it to practical problems.

c. Subject matter: Analysis of loading and axial stresses in beams of any general cross – section, particularly those composed of rectangular elements. Comparison with strain gauge readings wherever appropriate.

Analysis of Stress and Strain at a point (20 hours): The aim is to understand and apply the analysis of stress and strain at a point in a loaded component.

d. Subject matter: Oblique stress, simple tension, pure shear, pure normal stresses on given planes, general 2 – dimensional stress system, principal planes, principal stresses, maximum shear stress, Mohr's stress circle. Poisson's ratio, two – dimensional stress system, principal strains in 3 – dimensional, principal stresses determined from principal strains, analysis of strain, Mohr's strain circle, volumetric strain, energy, shear strain energy, theories of failure. Elastic constants. Relationship between modulus of elasticity and modulus of rigidity.

References:

1. Titerington and Rimmer – "Applied Mechanics".

2. R.C. Stephens and J.J. Ward – "Applied Mechanics".

3. Crandall, Dahl, Lardner – "An Introduction to the Mechanics of Solids".

4. J. Hannah and M.J. Hillier – "Applied Mechanics".

5. G.H. Ryder, strength of materials, third edition, 1969, Macmillan and company limited.

Engineering Dynamics II (50 hours)

The overall aims of engineering dynamics II are as follows:

To extend the students' understanding of dynamics and to describe and solve problems involving simple harmonic motion.

Kinetics of Rigid Bodies (Angular Motion) (20 hours): The aims are to understand the principles of angular momentum and to state the laws of, and solve problems associated with, angular motion.

a. Subject matter: Angular momentum, Newton's second law applied to a rotating body, moment of inertia, radius of gyration, work done by a constant and variable torques, power kinetic energy of rotation, kinetic energy of a body possessing translation and rotation, angular impulse, conservation of linear momentum.

Simple Harmonic Motion (15 hours): The aim is to describe and solve problems involving simple harmonic motion.

b. Subject matter: Description of the relationships of: Restoring force, displacement, displacement time, velocity time and acceleration, displacement, definition of simple harmonic motion, equations of motion, circular – simple harmonic motion, simple pendulum, spring mass system, compound pendulum.

4.6.3. Velocity and Acceleration Diagrams (15 hours): The aim is to construct velocity and acceleration diagrams for mechanisms and determine the forces in the links.

c. Subject matter: Relative velocity of two points on a link, velocity diagram, four bar linkages, velocities in the slider crank mechanisms, velocity of a block sliding on a rotating link, instantaneous center method.

Relative accelerations of points on a link, tangential and radial components of acceleration, Coriolis component of acceleration, inertia force on a link, input and output links, forces on links of a mechanism, power transmitted by a mechanism, analytical determination of velocity and acceleration in crank and connecting rod, forces in crank and connected rod.

References:

1. Titherington and Rimmer – "Engineering Science".

2. Titherington and Rimmer – "Applied Mechanics".

3. J. Hannah and M.J. Hillier – "Applied Mechanics".

4. J. Hannah – "Mechanics of Machines".

Mathematics and Computing II (90 hours)

The overall aims of mathematics and computing II are as follows:

To provide the student with all the mathematical and statistical techniques needed elsewhere in the course and to enable the student to solve engineering problems mathematically. To introduce students to the application of computers to engineering problems.

Calculus (40 hours): The aim is to extend the student's knowledge of calculus and to give a firm understanding of differential equations and their solution methods.

a. Subject matter:

- Inverse trigonometric and hyperbolic functions and their derivatives.
- McLaurin and Taylor's theorems.
- Multiple integrals, integrals along lines and curves.
- Partial differentiation, small changes formulae, maxima and minima in two or more dimensions.

- Introduction to differential equations, general and particular solutions.
- Solution of separable solutions, equation homogeneous in y/x.
- First order linear equations. Second, order linear, homogeneous equations, second order inhomogeneous equations, particular integrals.

Probability and Statistics (30 hours): The aim is to introduce the student to probability distributions and their expectations; and to introduce students to the fundamentals of hypothesis testing.

b. Subject matter: Normal probability law and its approximation to the binomial law. Discrete and continuous probability distributions, expectation. Point and interval estimation. Simple tests of hypotheses, z test, t test and F test. Confidence intervals. Chi – squared test.

Advanced Mathematics (15 hours): The aim is to provide specialist mathematical techniques, which will be used in, advanced parts of the course. It will only be possible to cover these topics at an introductory level.

c. Subject matter:

- Introduction to vectors in two and three dimensions, addition and subtraction, scalar and vector products, triple products.
- Application to mechanics and to geometry.
- Introduction to Laplace transforms. Properties and inverse transform. Applications to second order inhomogeneous differential equations with step and ramp functions.

Further Topics: If time permits, it may be possible to cover the following topics:

d. Subject matter:

- Eigenvalues and eigenvectors, characteristic equation.
- Application to mechanics.

Computing (15 hours): The aim is to introduce the student to the application of computers to engineering problems.

e. Subject matter: Introduction to the computer. Processor, memory, file store, languages, compilers and interpreters. Introduction to BASIC applications to simple engineering problems of a numerical nature.

References:

1. Stroud K.A., Engineering Mathematics, second edition, 1982. MacMillan.
2. Morris J., Mathematics for Mechanical and Production Engineers Level IV, 1981.
3. Miller I., and Freund J.E., Probability and Statistics for Engineers, second edition, 1977, Prentice Hall.
4. Alcock D., Illustrating BASIC, 1977, Cambridge University Press.
5. Spiegel, M.R., Probability and Statistics, 1980, Schaum's Series, McGraw Hill.
6. Kreyszig E., Advanced Engineering Mathematics, 1972, Wiley.
7. Bajpai A.C. and others, Advanced Engineering Mathematics, 1974, Wiley.
8. Gottfried B.S., Programming with BASIC, 1982, Schaum's Series, McGraw Hill.

Manufacturing Processes II (90 hours)

The overall aims of manufacturing processes II are as follows:

To extend the students' knowledge of machining principles to a level such that he can recognize and implement an appropriate machining process for a given component.

To familiarize the student with the principles of the many common joining processes used in engineering.

To extend the students' knowledge of metrology to a more useful working level.

Machining (40 hours): The expected learning outcome is that the student will be conversant with a wider range of manufacturing processes; and be competent to select the most appropriate manufacturing processes.

a. Subject matter:

Copying and Generating (4 hours)

Principle of copy machining, application or turning and milling machines, servomechanism, limitations of the process.

Special Turning Processes (5 hours): Principles of single and multi – start screw cutting by center lathe and thread milling. Select and justify either method. Form relieving on a center lathe.

Special Milling Processes (6 hours):

- Operating principle of the dividing head.
- Differential indexing. Use of dividing head for helical milling and cam milling.

Form Tools (2 hours): Types (flat, tangential, circular), with and without rake, design of form tool. Tool holders.

Broaching (3 hours): Features and broach nomenclature, puller, broaching machines, types of operation, classification of broaches.

Abrasive Machining (12 hours):

- Jig boring and jig grinding: justify appropriate method having regard to accuracy and surface finish requirement.
- Cylindrical Grinding: plunge, taper and plunge grinding, internal grinding.
- Form Grinding: thread grinding, pass – over and plunge cut, dressing thread grinding wheels, and splines.
- Finishing: Honing, lapping, superfinishing, select and justify a particular method for a given application.

Special Machining Processes (8 hours):

- Principles of: electro discharge machining, electrochemical machining and electrolytic grinding, chemical machining, ultrasonic machining.

- Application of the above processes.

Joining Processes (27 hours): The expected learning outcome is that the student will acquire a basic knowledge of the many common joining processes used in engineering; and understand the reasons for selecting a particular joining process.

Welding Processes (19 hours):

- Welding with Metal: Arc welding processes: tungsten inert gas, metal inert gas, submerged – arc and electro – slag.
- Resistance Welding: spot, seam, projection, butt and flash.
- Solid Phase Welding: friction and forge.
- Welding with Plastic: A brief review of friction (spin), hot gas, hot plate, hot wire.

Adhesives (3 hours):

- Mechanism of adhesion, types of adhesive (solvent loss, chemical reaction, hot melt).
- Designing for the use of adhesives.
- Summary of adhesives and applications.

Assembly Methods (5 hours):

Fastening Systems with Metal:

- Use of threaded fasteners – nuts and bolts of various types.
- Principle of clamping, and factors affecting performance.
- Use of non – threaded fasteners – variety of rivets and types of riveted joints. Taper and cotter pins, spring clips.

Fastening Systems with Plastic:

- Riveting, ultrasonic assembly press and snap fits.

Metrology (23 hours): The expected learning outcome is that the student will extend his knowledge of measurement techniques to a level, which complements the manufacturing knowledge of the student; and have a greater awareness of the methods of specifying component tolerance and geometric accuracy.

Screw Thread Measurement (6 hours):

- Measurement of effective, major and minor diameters of an external thread. Pitch and flank angle measurement.
- Common types of screw thread errors.
- Calculate virtual effective diameter.

Comparators (12 hours):

- Types, methods of magnification.
- Principles of mechanical, mechanical – optical, pneumatic, electrical, fluid displacement comparators.

Auto – Collimator and Alignment Telescope (5 hours):

- Optical system of auto – collimator, field of view, reflected image.
- Principle of the alignment telescope.
- Application for machine tool alignment testing.

References:

1. Manufacturing Technology 2, Timings, R.L. (Longman).
2. Manufacturing Technology 3, Timings, R.L. (Longman).
3. Manufacturing Technology 4, Bolton, W. (Butterworth).
4. Manufacturing Technology, Haslehurst, M. (Hodder and Stoughton).
5. Principles of Engineering Production, Lissaman, A.J. and Martin S.J. (Hodder and Stoughton).

Engineering Drawing and Design II (180 hours)

The overall aims of engineering drawing and design II are as follows:

To provide an understanding of the methodology of the design process and to develop abilities in inventiveness and decision making. To give the student a practical understanding of power transmission elements and the ability to use the theories of related subjects to analyze selected component design.

Design Process (50 hours): The aim is to provide an understanding of the systematic way of solving design problems.

a. Subject matter:

- Definition of problem and establishment of need, writing specifications.
- Methods of finding alternative solutions, brain or mental storming check lists, morphological analysis. Decision making methods. Feasibility studies.

Design for Strength (50 hours): The aim is to provide the essential knowledge for designing simple mechanical elements with strength as a major factor.

b. Subject matter

- Concept of factor of safety and working stress, stress conditions.
- Design of elements under different types of load, tension, compression, bending and torsion.
- Design of joints, welded joints, riveted joints.
- Design of power screws.

Power Transmission (80 hours): The aim is to provide an understanding of how various elements of power transmission system are selected or designed by the aid of catalogues of parts and handbooks.

c. Subject matter:

- Belts Drives: types of belts and pulleys, determination of speed and torque, selection of belt from catalogues.
- Gears: types of gears, torque and speed ratio, parameters of gears (no. of teeth, module, pitch etc.), determine tooth size by using standard formula. Selection of material for gears.
- Friction Clutches and Brakes: equation of torque and forces, friction materials used in brakes and clutches, heat dissipation.

- Bearings and Mounting of Bearings: types of bearings and their typical application. Design of bearing mounting.

Technical English II (60 hours)

The overall aims are to continue with the teaching of language and language skills necessary for the efficient reading of engineering textbooks, writing of essays and presentation of reports. This goal should be achieved through the four linguistic skills of reading, speaking, writing and listening.

Subject matter

- Introduction to technical writing.
- Use of grammar.
- Effective sentence structure.
- Report planning.
- Present simple tense and passive voice.
- Listening: the aim is to enable students to follow lectures and to develop the students' ability to understand different dialects.
- Speaking: the aim is to encourage students to speak out and to improve their ability to use English in discussion. This will be achieved by giving students time to select a topic and discuss the topic in the tutorials.

References

- Elements of technical writing by Marva T. Barnett.
- English in mechanical engineering by Eric H. Glendenning.
- Listening comprehensions and note – taking by K. James et al.
- Skills for reading by Keith Morrow.
- Nucleus English for Science and Technology. Teachers notes.
- Elements of technical writing.
- Writing scientific English by John Swales.
- The structure of technical English by A.J. Herbert.
- Writing with style by John R. Trimple.
- Form and style by Campbell.
- English for engineers by Clive Brasnett.
- At the end of each subject material there are enough references, but for further reading it is recommended to refer to references [39-64].

Conclusion

The second year of the mechanical and production engineering diploma course consists of eleven core subjects that includes Thermodynamics II, Fluid Mechanic II, Electrical Technology II, Properties of Materials II, Strength of Materials II, Applied Mechanics (Engineering Dynamics) II, Mathematics and Computing II, Manufacturing Processes II, Engineering Drawing and Design II, and Technical English II, Workshop Practice II and Laboratory Work II.

The overall objectives of the above-mentioned subjects are as briefly described below:

- Thermodynamics II: To introduce the second law in so far as it is required for an understanding of the principles underlying the achievement of high thermal efficiency (Carnot cycle) and to enable the student to be able to use isentropic efficiencies in final year of study. To appreciate the components, operation and control of S.I. and C.I. engines, and to analyze their ideal thermodynamic cycles. To enable the student to understand the practical and theoretical principles of operation of a variety of compressor types. To provide an understanding of the principles used to determine the properties of air – vapor mixtures.
- Fluid Mechanic II: To analyze the nature and effect of forces exerted on partially and totally submerged bodies. To examine and understand the nature and effect of forces exerted by fluids contained in moving vessels on the vessel. To enable simple pipework and power transmission systems to be understood and analyzed. To provide an understanding of water supply and demand problems. To provide a practical understanding of components and the operation of pumps and turbines.
- Electrical Technology II: To give the student an understanding of the basic principles and practice concerned with 3 phase STAR and DELTA connected systems. To introduce the student to theoretical and practical concepts associated with DC and AC generators/motors. To give an appreciation of control and installation of electrical machines with particular emphasis on speed control. To introduce the student to discrete electronic components and some of their applications in mechanical/production engineering. To give the student an appreciation of power control devices and electronics associated with control of machines.
- Properties of Materials II: To describe the iron – carbon diagram, explaining the effect of percentage carbon on the mechanical properties of carbon steel and heat treatment processes. To have a knowledge of non – ferrous alloys and relate them to their applications. To have a knowledge of the structure and properties of polymeric materials. To have an outline of the structure and properties of ceramics. To have a knowledge of what a composite is, how the structure is built up and the relation of fiber direction to properties.
- Strength of Materials II: To develop and use the theory of simple bending of symmetrical and unsymmetrical beams. To develop the theory of torsion of circular section bars. To develop the theory for axial stresses in beams and apply it to practical problems. To understand and apply the analysis of stress and strain at a point in a loaded component.
- Applied Mechanics (Engineering Dynamics) II: To understand the principles of angular momentum and to state the laws of, and solve problems associated with, angular motion. To describe and solve problems involving simple harmonic motion. To construct velocity and acceleration diagrams for

mechanisms and determine the forces in the links.

- Mathematics and Computing II: To extend the student's knowledge of calculus and to give a firm understanding of differential equations and their solution methods. To introduce the student to probability distributions and their expectations; and to introduce students to the fundamentals of hypothesis testing. To provide specialist mathematical techniques which will be used in advanced parts of the course; it will only be possible to cover these topics at an introductory level. To introduce the student to the application of computers to engineering problems.

- Manufacturing Processes II: the expected learning outcome is that the student will be conversant with a wider range of manufacturing processes; be competent to select the most appropriate manufacturing processes; acquire a basic knowledge of the many common joining processes used in engineering; understand the reasons for selecting a particular joining process; extend his knowledge of measuring techniques to a level which complements the manufacturing knowledge of the student; have a greater awareness of the methods of specifying component tolerance and geometric accuracy.

- Engineering Drawing and Design II: To provide an understanding of the systematic way of solving design problems. To provide the essential knowledge for designing simple mechanical elements with strength as a major factor. To provide an understanding of how various elements of power transmission system are selected or designed by the aid of catalogues of parts and handbooks.

- Technical English II: The aim of reading skill is to make students aware of the manner in which English is used in written communication, to help them develop techniques of reading and to provide them with a guide for their own writing and to develop an active reader who can vary his approach and strategy according to his needs at a particular stage in his development. The aim of writing skill is to teach the elements of technical writing and to enable students to communicate effectively with others, to teach the basic principles and rules used in formal communication and to explain procedures for organizing and writing technical reports. The aim of listening is to enable students to follow lectures and to develop the student's ability to understand different dialects. The aim of speaking is to encourage students to speak out and to improve their ability to use English in discussions. This will be achieved by giving students time to select a topic and discuss the topic in the tutorials.

- Workshop Practice II and Laboratory Work II: The overall aims are to enable the technicians to develop the necessary hand and operational skills which will enable them to become competent in specific hand skills for the successful maintenance of workshop equipment and to develop expertise in the operation of machine tools and associated plant. The aims of the laboratory work are to allow the student to gain confidence in the use of equipment with due regard to scientific method and associated measuring techniques.

The aim of teaching and practicing electrical installation is to provide the student with practical experience related to the safe and effective connection of single and three phase supply to electrical equipment; to give the student a practical experience in the use of electrical and electronic instruments for the testing of electrical equipment and connections. The aim of machining shop is to provide the student with the general guide lines required for the satisfactory and safe functioning of a manufacturing workshop; to provide practical experience in the safe operation of a center lathe related to the production of work machined between centers and in three and four jaw chucks, and to relate theoretical knowledge to the processes described above; to provide some limited experience in the use of milling, shaping and grinding machines. The aim of foundry work is to provide practical experience of preparation of molding sand, molds, cores and castings. The aim of forging practice is to provide practical experience in the use of hand forging tools and in the shaping of metals by hot deformation; to provide practical experience in the heat treatment of steels. The aim of elementary carpentry and pattern making shop is to provide practical experience in using carpentry hand tools and to develop hand skills on woodwork and pattern making. The aim of bench work is to provide practical experience in the use of hand tools in fitting, marking out, thread cutting, drilling and assembly. The aim of elementary welding practice is to introduce welding shop equipment and to provide essential practical experience in the safe use of gas and electric arc welding plant. The aim of welding and joining of metals is to develop first year experience of gas (oxy – acetylene) and arc (manual metal arc) and to extend it to more complex joints and to experience welding of various metals and cutting of steel using gas flame and electric arc. The aim of engine components workshop is to enable the student to gain a working knowledge of the function and assembly of the various components of SI and CI engines. Therefore, the student should learn the identification of the names and functions of the main parts of IC engines and other plants; techniques of dismantling and assembly of common diesel and petrol engines.

Acknowledgement

None.

Conflict of Interest

No conflict of interest.

References

1. Mechanical Engineering Subjects (2020) Mechanical Engineering Syllabus For BE, B.Tech Course.
2. Engineering "Mechanical Engineering" (2014) The American Heritage Dictionary of the English Language, Fourth Edition.
3. Paipetis SA, Ceccarelli Marco (2010) The Genius of Archimedes 23 Centuries of Influence on Mathematics, Science and Engineering: Proceedings of an International Conference held at Syracuse, Italy. Springer Science and Business Media. p. 416. ISBN 9789048190911.
4. Al-Jazari (1973) The Book of Knowledge of Ingenious Mechanical Devices: Kitáb fí ma'rifat al-hiyal al-handasiyya. Springer. ISBN 90-277-0329-9.

5. (2007) Accredited engineering programs in Canada by the Canadian Council of Professional Engineers Archived 10 May 2007 at the Wayback Machine.
6. (2008) Mechanical Engineering courses, MIT.
7. Rana NC, Joag PS (1991) Classical Mechanics. West Petal Nagar, New Delhi. Tata McGraw-Hill, pp. 6.
8. Duhem PMM (1886) Le Potential Thermodynamique ET SES Applications, Hermann, Paris.
9. Guggenheim EA (1949/1967) Thermodynamics. An Advanced Treatment for Chemists and Physicists, 1st edition 1949, 5th edition 1967, North-Holland, Amsterdam.
10. (2014) Modern Tools Used in Mechanical Design Engineering by Sarah Loffler.
11. (2018) "What is Mechatronics Technology?".
12. Xia, Ting (2003) Introduction to Finite Element Analysis (FEA). UIOWA Engineering.
13. JL Meriam, LG Kraige (2002) Engineering Mechanics, Vol. I – Statics, Vol. II – Dynamics, 5th Ed., John Wiley.
14. H Gerling (1995) All about Machine Tools, New Age International.
15. KVenugopal (1998) Engineering Drawing and Graphics, Third Ed., New Age International.
16. WJ Luzadder, JM Duff (1995) Fundamentals of Engineering Drawing, 11th Ed., PHI.
17. Solid State Physics - by C. Kittel, 7th edition (Wiley Eastern).
18. Introduction to Electrodynamics - by David J. Griffith (PH I).
19. Engineering Thermodynamics by Shapiro and Moran, 7th edition.
20. Thermodynamics by Faires.
21. Shirley Seireg (2019) Friction and Lubrication in Mechanical Design, First Edition.
22. Bijay Sultanian (2019) Logan's Turbomachinery: Flow Path Design and Performance Fundamentals, Third Edition.
23. James W Murdock (1993) Fundamental Fluid Mechanics for the Practicing Engineer, First Edition.
24. Bell (1993) Industrial Noise Control: Fundamentals and Applications, Second Edition.
25. V Ganapathy (2017) Steam Generators and Waste Heat Boilers: For Process and Plant Engineers, First Edition.
26. Osama Mohammed Elmardi Suleiman Khayal (2020) A REVIEW STUDY OF TECHNICAL EDUCATION IN THE DEMOCRATIC REPUBLIC OF SUDAN, International Journal of Advanced Engineering and Management 5(2): 9-23.
27. Osama Mohammed Elmardi Suleiman Khayal (2020) Solid Mechanics, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
28. Osama Mohammed Elmardi Suleiman Khayal (2020) Solar Energy Applications, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
29. Osama Mohammed Elmardi Suleiman Khayal (2021) Mechanical Engineering, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
30. Salaheldin Hassabelgabo Ibrahim, Osama Mohammed Elmardi Suleiman Khayal (2020) Design and Analysis of Photovoltaic Diesel Hybrid Power System, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
31. Osama Mohammed Elmardi Suleiman Khayal (2021) Corrosion and Biofouling, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
32. Osama Mohammed Elmardi Suleiman Khayal (2021) Air Conditioning Systems, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
33. Osama Mohammed Elmardi Suleiman Khayal (2020) TECHNICAL EDUCATION IN SUDAN, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
34. Osama Mohammed Elmardi Suleiman (2020) Fundamentals of Economics in Engineering Projects, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
35. Osama Mohammed Elmardi Suleiman (2021) Engineering Psychology and Ergonomics, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
36. Osama Mohammed Elmardi Suleiman (2020) BIOGAS PLANTS TECHNOLOGY, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
37. Osama Mohammed Elmardi Suleiman (2017) Solution of Problems in Heat Transfer Transient Conduction or Unsteady Conduction, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany, and ISBN: 978-3-659-66822-7.
38. Osama Mohammed Elmardi Suleiman (2015) Further Experimental Research Work on Water Current Turbines, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany.
39. Michael Volk (2013) Pump Characteristics and Applications, Third Edition.
40. Bryan R Fischer (2011) Mechanical Tolerance Stack up and Analysis, Second Edition.
41. Ronald Huston, Harold Josephs (2008) Practical Stress Analysis in Engineering Design, Third Edition.
42. Eugene L Keating (2007) Applied Combustion, Second Edition.
43. American Chain Association (2005) Standard Handbook of Chains: Chains for Power Transmission and Material Handling, Second Edition.
44. Subrata Mukherjee, Yu Xie Mukherjee (2005) Boundary Methods: Elements, Contours, and Nodes, First Edition, March 17, 2005.
45. Raymond G. Bayer, Engineering Design for Wear, Revised and Expanded, 2nd Edition.
46. David Mills, Mark G Jones, Vijay K Agarwal (2004) Handbook of Pneumatic Conveying Engineering, 1st Edition.
47. M Bradford Clifton, Wesley P Townsend, Henry MB Bird, Robert E Albano (2003) Target Costing: Market Driven Product Design, 1st Edition.
48. J Derek Smith (2003) Gear Noise and Vibration, Second Edition.
49. Sunil Kumar Pullarcot (2002) Practical Guide to Pressure Vessel Manufacturing, First Edition.
50. Ronald Huston, CQ Liu (2001) Formulas for Dynamic Analysis, 1st Edition.
51. Franklin Fisher (2000) Probability Applications in Mechanical Design, 1st Edition.
52. Muller (1998) Fluid Sealing Technology: Principles and Applications, First Edition.
53. Thomas Sixsmith, Reinhard Hanselka (1997) Handbook of Thermoplastic Piping System Design, First Edition.
54. Hah (1997) Turbomachinery Fluid Dynamics and Heat Transfer, First Edition.
55. Les Horve (1996) Shaft Seals for Dynamic Applications, First Edition.
56. John Bickford (1995) An Introduction to the Design and Behavior of Bolted Joints, Revised and Expanded, Third Edition, July 19, 1995.
57. Robert F Landel, Lawrence E Nielsen (1993) Mechanical Properties of Polymers and Composites, 2nd Edition.

58. Lyndon O Barton (1993) Mechanism Analysis: Simplified and Graphical Techniques, Second Edition.

59. Jensen (1991) Classical and Modern Mechanisms for Engineers and Inventors, 1st Edition.

60. Edward R Champion (1988) Finite Element Analysis with Personal Computers, First Edition.

61. Sylveste Campbell (1987) Solid-State AC Motor Controls Selection and Application, First Edition.

62. Trietley (1986) Transducers in Mechanical and Electronic Design, 1st Edition.

63. GS Haviland (1986) Machinery Adhesives for Locking, Retaining, and Sealing, 1st Edition.

64. Osama Mohammed Elmardi Suleiman Khayal (2021) A TEXTBOOK IN THE SYLLABUSES OF DIPLOMA IN MECHANICAL AND PRODUCTION ENGINEERING, LAP LAMBERT Academic Publishing, Member of Omni Scriptum Publishing Group, Germany, and ISBN: 978-620-4-18395-4.