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A TEXTBOOK IN THE
SYLLABUSES OF DIPLOMA IN MECHANICAL AND PRODUCTION ENGINEERING

SUBJECT CONTENTS OF FIRST, SECOND AND THIRD YEARS

IN MECHANICAL ENGINEERING COLLEGE – ATBARA (MECA)

September 1985

Updated July 2021

This Textbook Published on the 50th Anniversary of Establishing Mechanical Engineering College Atbara (MECA) that is Now Renamed as Faculty of Engineering and Technology (FET) after it has been amalgamated to Nile Valley University

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July 2021

Dedication

In the Name of Allah, the Merciful, the Compassionate

All praise is due to Allah and blessings and peace is upon his messenger and servant, Mohammed, and upon his family and companions and whoever follows his guidance until the day of resurrection.

To the memory of Professor Sabir Mohammed Salih, Professor Elfadil Adam Abdallah, Associate Professor Mohi-Eldin Idris Harba, Associate Professor Hashim Ahmed Ali, Associate Professor Abdel-Jaleel Yousef, Lecturer Ishraga Salih, Lecturer Intisar Abdu and Associate Professor Salah Ahmed Ali who they taught me the greatest value of hard work and encouraged me in all our endeavors and who also contributed greatly in the establishment and development of the Mechanical Engineering College Atbara (MECA).

This textbook is dedicated mainly to undergraduate and graduate engineering students, especially mechanical, production engineering students, universities and high institutes teaching staff and curriculum and syllabuses designers in mechanical and industrial engineering where most of the materials presented are focused on introduction and historical background of the mechanical engineering college which situated in Atbara city – river Nile state – northern Sudan. The study includes introduction, course philosophy and objectives, syllabuses of the first year of the diploma course, syllabuses of the second year of the diploma course, syllabuses of the third year of the diploma course and finally the concluding remarks of the study.

Last but not least, may Allah accepts this humble work and I hope that it will be beneficial to its readers.

Acknowledgements

I am indebted to many people. Published texts in the necessity and importance of studying engineering syllabuses of different universities and high institutes around the globe have been contributed to the author's thinking. The present study has been considered from the point of view of introduction, course philosophy and objectives, syllabuses of the first year of the diploma course, syllabuses of the second year of the diploma course, and syllabuses of the third year of the diploma course and finally the concluding remarks of the study. Members of Mechanical and Production Engineering Departments at Faculty of Engineering and Technology, Nile Valley University - Atbara have served to sharpen and refine the treatment of the topics. The author is extremely grateful to them for constructive criticisms and valuable suggestions.

The author would like to acknowledge with deep thanks and gratitude the moral and financial support extended to him by Nile Valley University via its Faculty of Engineering and Technology, Red Sea University, Kassala University and factories of cements and pipe Lines Company in the River Nile State.

My thanks is extended to my colleagues in the Mechanical Engineering Department, Faculty of Engineering and Technology, Nile Valley University, Atbara, Sudan for giving their great experience in writing reports, researches and books according to the standard format, and also for revising several times the manuscript of the present book.

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Finally I would like to acknowledge the generous assistance of the staff at different levels working in the industrial liaison and consultancy unit, Atbara and the mechanical and production engineering departments' staff working in the different workshops and laboratories in the Faculty of Engineering and Technology, Atbara.

Preface

The diploma in mechanical and production engineering has been developed as a cooperative venture between Leeds Polytechnic of U.K. and the Mechanical Engineering College Atbara of Sudan, under the auspices of the British Council.

The Mechanical Engineering College Atbara has offered a 3-year 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 '.

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

Chapter one in this book includes introduction of the mechanical engineering college Atbara. The different topics in this chapter are discussed from the viewpoints of general introduction and historical background, faculty of engineering and technology departments, academic programs of BSc and Diploma courses, admission requirements to FET, academic system, degrees and certificates awarded by the FET, industrial liaison and consultancy unit (ILCU).

In chapter two the course philosophy and objectives are presented and discussed thoroughly from the considerations of the national need for technician engineers, aim and objectives of the diploma course, admission requirements of the diploma course and the course of the mechanical engineering diploma, course management, examination and assessment procedures.

Chapter three deliberates syllabuses of the first year diploma course from the considerations of thermodynamics I, fluid mechanic I, electrical technology I, properties of materials I, strength of materials I, applied mechanics I, mathematics and computing I, manufacturing processes I, engineering drawing and design I, technical English I, and workshop practice I and II.

In chapter four syllabuses of the second year of the diploma course is discussed from the viewpoints of thermodynamics II, fluid mechanics II, electrical technology II, properties of materials II, strength of materials II, engineering dynamics II, mathematics and computing II, manufacturing processes II, engineering drawing and design II, technical English II.

Chapter five deliberates syllabuses of the third year of the diploma course from the considerations of common core subjects for mechanical engineering power option and production engineering option which includes properties of materials; strength of materials; engineering dynamics, control and instrumentation; organization of engineering projects; final year projects; subjects content of the third year - mechanical engineering power option which includes design and integrative studies, thermodynamics III, fluid mechanics III, plant installation and maintenance; subjects content of the third year - mechanical engineering production option which includes design and integrative studies, workshop practice, manufacturing technology I, manufacturing technology II, production planning and control.

The book is suitable as a textbook and a reference for curricula and syllabuses designers of the course study of mechanical and production engineering diploma.

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Chapter One

Introduction

1.1 The Importance of Technical Education

At a time when technological innovations are intrinsically coupled with virtually every aspect of society, it is imperative to develop a scientific and technically literate society. However, broad indicators of shortcomings in developing technical competencies within the U.S. population at large indicate the scale of the challenge at hand. In 2001, companies spent over $57 billion on training, much of which paid for workers' training in basic skills that should have been learned in school [1]. Meanwhile, the United States' poor performance in teaching mathematics and science which was shown in results from the Third International Mathematics and Science Study and the National Assessment of Educational Progress eliminates many of the best and brightest schoolchildren from the ranks of future scientists and engineers. With little chance to learn in school how science and mathematics skills might translate into professionally useful knowledge, students are unable to make informed choices about further education and work options. As a result, some unprepared students undertake science and engineering studies in college, only to drop out; other, potentially capable, students never consider these subjects in the first place. In both cases, precious human and institutional resources are squandered.

An increasingly large share of the workforce consists of women and minorities. The 2000 report of the Commission on the Advancement of Women & Minorities in Science, Engineering, and Technology notes that, although African-Americans and Hispanics represent 3 percent each of the technical workforce, they are each 15 percent of the school-age population. Demographic projections only reinforce this point: by 2035, these students will rise from about 30 percent to nearly 50 percent of the nation's schoolchildren [2] and [3]. Twenty years of improvements in mathematics and science achievement have brought girls near parity with boys on National Assessment of Educational Progress tests. However, as they move through middle and high school, girls' interest in mathematics and science wanes, as teacher, parent, peer, and media influences work in complex, often unconscious, ways to discourage their pursuit of these subjects. As a result, women represent only 19 percent of the technical workforce, although they represent 46 percent of all American workers. Success in encouraging and retaining women and underrepresented minorities throughout their pre-college, college, and postgraduate years must be a core component of enhancing the U.S. science and engineering workforce.

A curriculum framework based on connecting science and mathematics to the world around them can also impart habits of mind to students that yield benefits beyond workplace productivity and career advancement. At the simplest level, the imperatives of good citizenship increasingly require acquaintance with fundamental principles of scientific knowledge. Taking a problem-based approach to learning, engineering education asks students to integrate knowledge and practices from the sciences, economics, language, and creative arts. Thus, elements of science and engineering education are important contributors to developing fully literate citizens.

Recent changes in the practice of engineering education span the content of the curriculum, the organizational and operational principles of engineering education programs, and the opportunities for learning available in the field. This reform in engineering education has been dramatic, perhaps matched only by the development of science-based engineering education in the 1950s, and continues to occur not only in higher education but also in the K-12 arena. Codified in the Accreditation Board for Engineering and Technology (ABET) Engineering Criteria 2000, new approaches to engineering accreditation require engineering programs to incorporate critical professional skills and content into their curricula and to strive for adaptability and accountability to their constituencies in their operations and principles. In line with this trend, engineering educators have significantly revised the ways in which they assess the effectiveness of their own programs. Previously, engineering education assessment consisted largely in monitoring schools' adherence to a fairly uniform curriculum. Reform in engineering education assessment now holds schools to a standard of continuous self-improvement, encouraging schools to develop rigorous practices for defining educational missions and demonstrating results that show fulfillment of these missions.

In addition to the fundamental science and engineering content, increasingly important elements in the engineering curriculum are effective communications, working in teams, and organizational management. Recognizing that new technologies drive so much economic growth, more and more engineering educators are teaching entrepreneurship to students, many of whom will provide the technical know-how for new companies and innovative products to come. And in an effort to stem the tide of attrition among engineering students, colleges increasingly provide substantive, hands-on design and engineering content in freshman courses emphasizing the creative aspects of engineering. This marks a change from the traditional engineering curriculum that puts students through rigorous training in mathematics and science before providing a context for the engineering process.

Engineering programs are evolving to make available opportunities to pursue diverse areas of study that match the rapid pace of discovery and innovation in science and engineering, many of which are interdisciplinary. Advances in understanding and manipulating the mechanics of molecular and atomic activity have created new realms for engineering education and research. Significant new programs in bioengineering and nanotechnology have been initiated at many schools, drawing rapidly growing numbers of students.

A great and vibrant engineering education is very crucial in the society. Therefore, this activity of teaching knowledge benefits and improves the economic condition of any country.

You may wonder why and how pursuing engineering education can the condition improve. Well, the graduates learn and develop products, which can solve the problems existing in a society. In addition, the graduated students will acquire great skills needed for further research and discovery.

An engineering if pursued properly can possess skills needed for an individual. In addition, there are many areas where there is scope for improvement.

In a vocational school, the students are made to prepare for the world. Loads of practical sessions, beyond the classroom technique and laboratories to be being employed to train the students. The universities are also trying to build a broad spectrum of foundation so that the students are free to contribute to numerous fields out there. In 21st century, education has become a necessity. A much-needed necessity. For this we need best engineering educational lab equipment. By which, one can get all the practical knowledge for better implementation.

This has become the most important mission for every country to increase the rate and quality of education. Thus, engineering by nature is creation of things. Innovation is something which engineers are innately fond of doing.

In addition, with rapidly improving technology, the need for engineering education has found greater importance. Engineers are evolving and thus the engineering schools are evolving. This branch has also made people to evolve as world leaders such as Satya Nadella and others.

Today, engineering applications require engineers to develop and update their knowledge in professional life in a continuous manner since technology is rapidly changing and becoming more complex. Unfortunately, due to lack of knowledge and training, trial and error method is widely used in most of the applications by newly graduated technical staff. However, this method could be a cause of huge economic losses, and undermines occupational safety and health at work. At present, in most countries, Bachelor of Sciences education in engineering is a four-year program. Although, in light of the Bologna Declaration, there is a trend in recent reforms towards 3-year Bachelors in EU countries, since, today engineering activities require high level education giving theory and the related knowledge and training on application in detail on different, interrelated branches of science and technology, engineering education should be more scientifically oriented. Such an education requires more than 3 years for students graduated from general High Schools. There is today a consensus that the professional engineering degree should take totally five years in a two-tier structure following secondary school. In this paper, it is proposed that the period of engineering education in the first cycle should be 3 years for the graduates of technical high schools and a minimum of 4 for the ones of other schools. Instead of Master of Science programs, master of engineering programs offering courses with a content giving basic knowledge, which is not renewed in a period of few years, on the design of engineering systems and structures and on the operation details of complicated engineering systems should be the prerequisite for professional engineering degree. The mission statement of technology faculties is discussed and interpreted. The mission laid out during the formation of Technology Faculties, established as an alternative to Engineering Faculties, which have now been providing education for a few years (in Turkey) should be reconsidered. These schools should be restructured as graduate schools in order to take on the role for teaching graduates of Engineering Faculties, who select technical track for being a professional engineer, to provide them with application details in a scientific manner [4].

1.2 General Introduction and Historical Background of Technical Education in Sudan

The qualifying of the Technician needs several capabilities such as establishing laboratories and specialized workshops, preparation and qualifying of instructors and trainers; and updating and review of the curricula in accordance with the needs of the labor market and development.

The challenges that Face technical education in Sudan could be summarized in the following points: Improvement of the ratio of Diploma to B.Sc. graduates, technical and academic financing through government , foreign donations, private sector , and trainee fees , capacity building of teachers and trainers, job description specification for each specialization, development of curricula to suit the labor market, improving the quality and quantity of technical education, flexibility in admission, diversification of programs, and encouraging students to be enrolled in this kind of study**.**

There are considerable opportunities for developing a diverse array of marketable and apprenticeable trades specific to Sudan which can contribute to sustainable development and post democratic transformation reconstruction. There is no doubt that technical education is crucial if local people are to participate in nation-building and benefit from expanding market activity in Sudan [5] – [28].

Technical education is education that prepares people to work as a technician or in various jobs such as a tradesman or an artisan. Technical education is sometimes referred to as career and technical education [29]. A technical school is a type of educational institution specifically designed to provide technical education.

Technical education can take place at the post-secondary, further education, or higher education level and can interact with the apprenticeship system. At the post-secondary level, technical education is often provided by highly specialized trade schools, technical schools, community colleges, colleges of further education (UK), universities, as well as institutes of technology (formerly called polytechnic institutes).

Historically, almost all technical education took place in the classroom or on the job site, with students learning trade skills and trade theory from accredited professors or established professionals. However, in recent years, online technical education has grown in popularity, making learning various trade skills and soft skills from established professionals easier than ever for students, even those who may live far away from a traditional technical school.

Sudan pre-independence public education system was designed by the colonial power to produce civil servants and professionals. Post-independence, the system underwent many changes, aimed at meeting the country dynamic economic and social needs. Up to the advent of national salvation government, the education in Sudan is free and compulsory for children aged from 6 to 13. Primary education lasts six years, followed by three years of intermediate school and finally another three years of secondary school. Students can choose between two academic tracks scientific and literary option and/or technical track (agricultural, industrial, and commercial).

The language of education at all levels is Arabic. Schools are concentrated in urban residential areas. During the rule of salvation government there was a major change in education system which resulted in increasing primary education two years, cancelling the intermediate level and leaving secondary level as it is. Primary school enrollment in 2001 was estimated by the World Bank at 46% of eligible students and 21% of eligible secondary school students. Enrollment varies widely, falling below 20% in some provinces.

Besides public education, Egyptian educational missions and missionary schools have contributed a great deal to education in Sudan, with activities extending to a number of provinces.

Private education at primary and secondary levels was introduced in the 1950s, and spread quickly after the deterioration in public education. Although there are no exact figures, there are known to be several expensive and prestigious private schools in Khartoum, accommodating pupils from upper class families and teaching in English.

Higher education emerged in 1902 with the establishment of Gordon Memorial College. It changed its name to the Khartoum University College and broke away from the University of London in 1956, becoming the University of Khartoum.

Before independence, several educational institutions were established to award diplomas to government employees who had completed secondary school. One of these was the Khartoum Technical Institute, the leading center of technical education in Sudan. It became the Khartoum Polytechnic Institute in 1975 and was given university status in 1990, becoming the Sudan University of Science and Technology.

Cairo University (Khartoum Branch) was established in 1955 and renamed Al-Neelein University in 1993. In 1975, the universities of Juba and Gezira were established.

After the revolution of higher education of 1990, the number of government universities jumped from five to 35 in 2010. At the same time, higher education became a field of private investments and tens of private universities and colleges were opened in all parts of the country, with a noticeable concentration in Khartoum. The number of private universities and colleges is now estimated to be around 80. This tremendous upsurge resulted in a shocking drop in government expenditure on public education, accounting for only 1% in 2010 and 2% in 2011.

The rapid expansion of higher education institutions was accompanied by a marked deterioration in the quality of the education provided, and some 45% of graduates are unemployed [30] and [31].

Technical education is distinguished from other types of education because of its direct link to the needs of the labor market, it promotes the economic and social life, and it follows up the new technical modifications. Figure 2.1 below shows the international pyramid for the proportionality of labor force. The qualifying of the Technician needs several capabilities such as: Establishing laboratories and specialized workshops; Preparation and qualifying of instructors and trainers; and Review of the curricula in accordance with the needs of the labor market and development. Figures 1.1 and 1.2 below respectively illustrate diagrammatically the ideal international pyramid for the proportionality of labor force and the technical education tracks as shown in Figure 2.2 below.

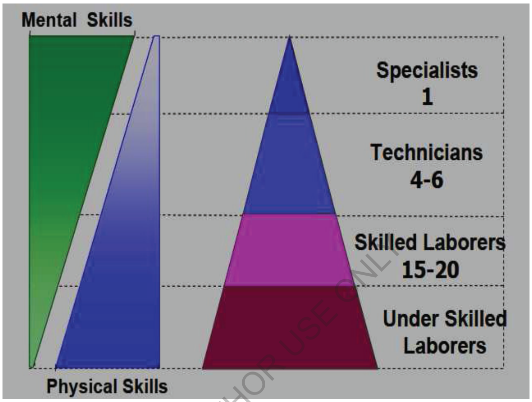

Figure 1.1 International Pyramid for the Proportionality of Labor Force

In 1902, Gordon Memorial college (GMC) established a vocational and technical education for secondary school (four years of study: two academic and two vocational).

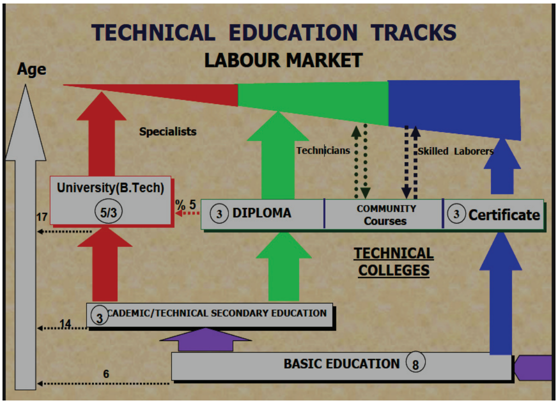

Figure 1.2 Technical Education Tracks

In 1939, Post-secondary technical education was introduced.

In 1951, Khartoum Technical Institute (KTI) was established and annexed to it all the training units in the different governmental departments. The period of study is three years after the completion of secondary school.

In 1962, the period of study in the Khartoum Technical Institute (KTI) for the diploma was increased from three years to four years.

In 1971, The (KTI) was divided and distributed to a number technical colleges in the different regions in the Sudan. One of these colleges is the mechanical engineering college Atbara (MECA).

In 1975, The (KTI) was transformed into the Institute of Technical Colleges (ITC).

In 1983, The (ITC) started studies of Bachelor degree of Technology (B. Tech.) plus the diploma degree.

In 1990, The (ITC) was transformed to the Sudan University of Science and Technology (SUST).

1.3 General Introduction to Mechanical Engineering College Atbara

The diploma in mechanical and production engineering has been developed as a cooperative venture between Leeds Polytechnic of U.K. and the Mechanical Engineering College Atbara of Sudan, under the auspices of the British Council.

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

Within the overall objectives of the university, the FET has the following specific objectives:

1. To qualify students to the BSc (Honors) Degree in Engineering or Engineering Diploma in the branches of engineering available in the faculty.
2. To provide students with basic science in engineering and technology and to upgrade their intellectual and practical abilities .
3. To contribute to social and economic developments in the country .
4. To provide postgraduate programs in engineering.
5. To link the students to the local industrial environment.
6. development of the industry through training programs, consultancy and applied research and studies.
7. To widespread knowledge and awareness in engineering through out the skilled labors community.
8. To contribute to society development through seminars, sessions and Industrial expositions.

9. To create and develop links with industry and engineering firms nationally and internationally .

1.4 Departments of FET

The Faculty of Engineering and Technology now has the following departments:

1. Mechanical Engineering Department.
2. Production Engineering Department..
3. Electrical & Electronics Engineering Department.
4. Civil Engineering Department.
5. Science department*.

*The Science department is an Auxiliary department, it does not award degrees or certificates, Its responsibility confines to supervision and teaching of basic science and university requirements subjects.

1.5 Academic Programs of FET

FET now executes BSC (Hounrs) programs in Engineering (5-years duration) and Engineering diploma programs (3-years duration).

In addition, FET executes the following MSC programs :

1. MSc in Engineering Management systems.
2. MSc in Manufacturing systems.
3. MSc in Control Engineering.
4. MSc in Mechanical Engineering.
5. MSc in Civil Engineering.

It also executes a PhD program in total technology.

In addition to that, there are a number of students registered for MSc & PhD by research in production, Mechanical and electrical & electronics engineering .

1.6 Admission to FET

The students who are admitted to FET must have the Secondary School Certificate and must:

1. Satisfy the requirements which have been set by the Governmental Admission Administration in the Ministry of Higher Education.

2. Satisfy the requirements which have been set by the University Admission Committee (UAC), or the FET Council .
3. Pass any interview which may be held by the UAC or by the FET.
4. Satisfy any medical requirements.

1.7 Academic System of FET

The academic system followed in the FET is a two semesters per year and the credit hours system is as described below:

A. BSc in Engineering programs:

The BSc program consists of five academic years, each year consists of two semesters.The semester consists of a number of credit hours ranging between 12 and 24 credit hours.

B. Engineering Diploma programs:

The Engineering Diploma program consists of three academic years which consist of two semesters. The semester consists of a number of credit hours ranging between 12 and 24 Credit hours.

1.8 Degrees and Certificates Awarded by the FET

The FET awards the following Degrees:

1- BSc (Honors) in Mechanical Engineering.
2- BSc (Honors) in production Engineering.
3- BSc (Honors) in Electrical &Electronics Engineering.
4- BSc (Honors) in Civil Engineering.

In Addition FET awards Engineering Diploma of three-years duration in the following desiplines:

1- Mechanical Engineering.
2- production Engineering.
3- Electrical &Electronics Engineering.
4- Civil Engineering.

1.9 Industrial Liaison and Consultancy Unit (ILCU)

The ILCU was established in 1984 with the purpose of linking the FET with the society. It is an integrated consultancy body and it offers its service in all branches of engineering to individuals and firms of the Engineering sector in the region.

The main objectives of the ILCU are as mentioned below:

1. To provide consultancy service to the Organization of the Engineering sector.
2. To carryout research and studies which lead to industry development.
3. To design and manufacture simple mini-projects suitable with the country economics.
4. To contribute to the development of man power capacities through well design and planned training courses.
5. To run training courses in the computer science and its applications, to individuals and members of engineering organizations in the region.
6. To help in manufacturing simple spareparts for machinaries and equipment as required by other organizations.
7. To provide maintenance service for autombiles, equipment and machinaries.
8. To establish and develop links with firms and organizations of the engineering sector.
9. To provide additional revenues to the FET.

Figure 1.3 below shows the main gate of the Faculty of Engineering and Technology – Atbara.

Figure 1.3 a Photo Showing the Main Gate of the Faculty of Engineering and Technology - Atbara

Chapter Two

Course Philosophy and Objectives of the Diploma Course

2.1 The National Need for Technician Engineers

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.

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 subjects reflects the national needs as they are seen at present, but attention is also paid to the future.

Consequently, the student will be introduced to computational methods and made aware of advances in technology that result.

2.2 Aim and Objectives

2.2.1 Course Objectives

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.

In realizing the course objective in terms of course design, four important factors have been taken into account:

A. Students entering the course have little or no natural engineering background and skills.

B. There is a need for technician engineers to be able to demonstrate that they have manual skills in addition to supervisory and academic skills.

C. Sudan is short of skilled technicians.

D. Many so called skilled laborers have learned their skills through informed back street apprenticeships. They are, consequently, severely handicapped and need to have their abilities developed and extended through further training. Atbara college graduates should be capable of doing this training.

2.2.2 Course Aims – Specific Abilities of the Atbara Graduate Technician Engineer

The aims of the course relate specifically to the skills to be acquired through the education provided. At the conclusion of the course, the graduate technician should be able to:

A. Design simple components, particularly as this applies to plant maintenance, repair, and development.

B. Maintain plant and machinery to a high standard.

C. Exhibit skills required in basic engineering manufacturing processes.

D. Organize work in manufacturing industry, maintenance and repair workshops or power plants.

E. Train skilled laborers to a higher standard.

In this context, the Atbara graduate might be expected to take up supervisory jobs in manufacturing and repair industry or operational work in power industries: e.g. supervisor (i.e. foreman), planning engineer, fault analyst, shift charge engineer, training supervisor/manager.

2.2.3 Course Aims – The Academic Level

The course is designed such that the academic level attained will reflect both the needs of the country in terms of technical skills, and of the need to educate to a recognizable standard, thereby giving the student the required status and the opportunity to extend his knowledge beyond diploma level.

Whilst in broad terms the aim is to achieve a standard equivalent to that of a UK Higher National Diploma, some variation about this mean has been allowed for in the design of the course.

In pitching the academic level, due regard has been taken of:

A. The academic level of entrants.

B. The time limit of 3 years, full – time. (Note: the academic year and the hours worked per week are higher than in UK: 36h/wk., 30 wk. /yr. (excluding exams) giving a total of 1080 h/yr.).

C. A curriculum design based on full laboratory and workshop facilities even though this requirement is not fully met at present.

D. A recognition that whilst the main objective is to produce technician engineers, the course should enable the ambitious student to follow the more advanced courses of study.

2.2.4 Course Aims – The Final Year

Years one and two may be regarded as providing the under – pinning and background knowledge essential to the more specific aims of the final year, when in addition to studying a core of subject material, the student selects to join either the mechanical engineering or the production engineering stream.

The aims relating to each subject are given below:

2.2.5 Common Core Subjects

1. Engineering Materials:

A technician should take part in design and manufacture of different components and should be able to select and prepare the right material for the job. He should be able to test and analyze the properties and strengths of the materials involving the use of stress analysis.

2. Engineering Dynamics and Control:

A technician should comprehend thoroughly the function and operation of moving parts in machinery and be able to analyze the forces acting on them, and to understand the instrumentation and control of pressure, temperature, speed, flow and quantities related to production equipment.

3. Organization of Engineering Projects:

A technician should be able to participate in the planning and execution of engineering projects with regard to layout, management and costing.

Management is defined as the control of small projects, planning, the organization of work force and utilization of equipment.

4. Engineering Design and Integrative Studies:

A technician should be able to read and produce engineering drawings, to participate in the process of design of different components and be capable of designing simple components without assistance.

The content of syllabi should be specifically aimed at the requirement to provide new designs of replacement parts for maintenance purposes.

In relation to integrative studies, the student should be taught to bring together the various components of the course for the solution of realistic engineering problems. The use of case studies is recommended for this purpose.

It is recognized that during the initial years of operation of the course, the integrative studies content may be relatively small; but it is hoped that as experience is gained, it will assume an increasingly important role within the final year.

In acknowledgment of the varied interests of the two groups, integrative studies has been divided into two groups, namely power and production.

5. Workshop Practice:

To acquire the skill required to manufacture a variety of items to given specifications using machine tools.

6. Projects:

To give the technician experience in the manufacture of small engineering components, thereby enabling him to exercise the knowledge acquired during his study and to appreciate working as a part of a team.

2.2.6 Power Group Subjects

1. Thermodynamics:

A technician should understand the theory of the various types of internal and external combustion engines and have a practical appreciation of their operation. He should be able to commission and test engines and should have a working knowledge of both refrigeration, air conditioning and heat transfer.

2. Fluid Mechanics:

A technician should know the theory related to hydraulic machinery, and be able to commission and test machinery with special reference to hydro – electric power generation and irrigation schemes.

3. Plant Installation and Maintenance:

A technician should be able to install, run and maintain (routine, preventive and corrective) common engineering plant.

2.2.7 Production Group Subjects

1. Manufacturing Technology:

A technician should be able to understand the technology of, and be competent in the use of machine tools in common use. He should have a working knowledge of selected metallic and non – metallic manufacturing processes. He should be capable of introducing new techniques and able to understand the relationship between technology and the efficiency of production.

2. Production Organization:

A technician should have a working knowledge of the principles of efficient work organization through the media of production planning, work measurement, scheduling, stock control and quality control. He should be capable of supervisory work within these areas.

2.3 Admission Requirements for the Diploma Course

Admission to the course is dependent upon each of the following:

1. A pass in the Sudan academic school certificate (or equivalent) with at least passes at credit level in mathematics, physics and an appropriate science based subject. Or
2. A pass in the Sudan technical school certificate (or equivalent) with at least passes at credit level in mathematics, engineering drawing and workshop technology. Plus
3. A pass in English language.

2.4 The Course of the Mechanical Engineering Diploma

2.4.1 Structure and Curriculum

The course is of three years duration with full time study occupying 30 weeks of each year.

The first and second years contain common material and in the final year, in addition to studying a common core, students elect to follow either the mechanical engineering power or production engineering options.

Included within the course a period of 12 weeks practical training within industry. This comprises a 6 weeks period in Sudan railways workshops in the first year, followed by a period of 6 weeks in selected manufacturing companies in Egypt during the second year.

2.4.2 Teaching Methods, Laboratory and Practical Work

The course has been designed to enable students to gain a practical and working understanding of engineering principles and as such, it is seen to be essential that students gain as much experience as possible. Laboratories and workshops are to be fully utilized with demonstration work being reduced to a minimum and student involvement increased to a maximum.

Teaching methods will vary according to subject matter, but again it is the intention to illustrate theory through practical applications, the use of simple models, slide and overhead projection, video material and visits to local industry.

2.4.3 Personal Tutorship

Care of individual students is the overall responsibility of the student counsellor, who may if he deems it necessary seeks the assistance of individual members of staff in helping students with problems of a personal nature.

2.5 Course Management

The course will be managed through the following committee structure.

2.5.1 Course Committee

2.5.1.1 Membership

Vice principal (chairperson)

Academic secretary (secretary)

Academic staff – 3 members

2.5.1.2 Terms of Reference

To receive recommendations from the examination board and the staff/student consultative committee and to discuss suggestions presented by individual members of staff.

The course committee reports to the academic board through the staff committee and appropriate executive decisions.

2.5.2 Examination Board

2.5.2.1 Membership

Principal (chairperson)

Academic secretary (secretary)

Examiners and co – examiners (internal)

External examiner

2.5.2.2 Terms of Reference

To process all examination results and assessment.

To make recommendations to the academic board in respect of progression, final award, grading and prize giving.

To consider examination regulations and to make recommendations to the academic board.

2.5.3 Staff/Students Consultative Committee

2.5.3.1 Membership

Two members of teaching staff

One representative from each of the classes

2.5.3.2 Terms of Reference

To provide a forum for discussion of matters of common interest relating to the operation of the course.

2.6 Examination and Assessment Procedures

2.6.1 General Regulations

1. The diploma of the mechanical engineering college Atbara (MECA) shall be awarded only to students who have satisfactorily completed the prescribed courses at the college and passed the total aggregate in each subject in mechanical engineering technician course.
2. The diploma of the college shall be awarded by the college academic board.
3. The decision of the academic board shall be final in all matters relating to the award of the college diploma.
4. All matters relating to the diploma courses concerning the conduct of examinations, the standard required, the processing of results and the academic awards shall be the responsibility of the academic board.

2.6.2 Examination Regulations

2.6.2.1 Entry for Examinations

1. No student shall be awarded the diploma unless he has satisfactorily completed the prescribed course of study and passed the total aggregate in each subject.
2. Throughout the session lecturers will give marks for course work and laboratory work and the students will be required to submit their relevant note – books for inspection as required by the lecturers and at the end of the session.
3. The assessment of the year's work shall be based on the coursework which comprises tests, tutorials and homework, and where relevant, on laboratory work as well.

4. Lecturers should hand in to the academic secretary, the assessment of the year's work marks at the end of each term.

5. Lecturers should enter students' attendance records in the attendance book kept by the academic secretary at the end of each month.

6. A student will not be permitted to sit for the examination in any subject unless he has attained a minimum of 80 percent of the maximum total attendance in that subject.

7. A student who is absent for more than 20% of the maximum total attendance at any time of the year in three or more subjects without valid reason during any time of the academic year may be dismissed.

8. In subjects where laboratory work constitutes part of year's work, no student shall be considered to have passed that subject unless he has satisfactorily completed all the prescribed laboratory work and attained a minimum of 50% of the marks.

9. Where appropriate, the training assessment mark should be entered with the final result under a separate heading. A student failing to attain 50% or more in the training assessment mark may, at the discretion of the academic board be barred from the sessional examinations.

10. A candidate who, having completed the appropriate course of study, is prevented by illness or any other legitimate reason from taking in whole or part of any examination for which he is entered, may be permitted by the academic board to take a substitute examination in the papers he missed, provided that a valid medical certificate or other evidence, is presented before the examination concerned.

11. A candidate who is absent from the whole, or part, of an examination without a legitimate reason shall be deemed to have failed the papers he missed.

12. A candidate who is absent from three or more papers in an examination without a legitimate reason shall not be given the chance to sit as an external candidate ever.

13. A student who has been barred from taking the examination in any subject shall be deemed to have failed in that subject.

2.6.2.2 Preparation for Examinations

1. There should be constituted an examination committee to conduct the examinations.

2. Examinations will be held at the end of each academic year of the diploma course and no student shall be permitted to proceed to a subsequent year without first having satisfied the academic board.

3. List of names and examination numbers of candidates entered for any examination shall be published in sufficient time before the examinations with instructions to candidates.

4. The examination timetable shall be published at least two weeks in advance of the examinations.

5. The sessional examinations will include all subjects take as part of that year's diploma course.

6. In such cases where practical work forms a part of the year's course, a practical examination will be held at the end of the sessions.

7. Examiners for each subject shall be nominated by the academic board on the recommendation of the staff board, and these will be either external and/or internal examiners.

8. For each subject, the academic board may nominate the lecturer of that subject as the examiner with at least one co – examiner.

9. Examination papers shall be so composed as to cover the syllabus of subject as far as practical.

10. The examiner shall prepare two papers of the same standard with model answers for both papers.

11. The examiner and co – examiner(s) shall hold a meeting whenever possible to discuss and agree on the final form of the examination papers.

Chapter Three

Syllabuses of the First Year Diploma Course

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

3.1 Thermodynamics I (45 hours)

3.1.1 Introduction to Thermodynamics (20 hours)

Subject Matter

Thermodynamics properties; pressure, temperature, volume, work, heat, internal energy, flow energy, units.

Principles of the heat engine; heat source, expansion work, heat sink, controls, thermal efficiency.

Properties of gases; equation of state, specific heats.

First law; systems, boundaries, energy balances and equations.

Non – flow energy equation; reversibility, P – V diagrams, constant volume, constant pressure, isothermal, adiabatic and polytropic processes.

Calculation of heat and work transfers in non – flow systems, cyclic operation.

Properties of liquids and vapors; phase changes, sensible/latent/super – heat, dryness fraction.

Use of fluid data tables to determine enthalpy and specific volume.

3.1.2 Heat Transfer (12 hours)

Subject Matter

Descriptive treatment of the three modes of heat transfer.

One dimensional conduction; thermal conductivity, heat transfer coefficients, Fourier's law.

Boundary layers, insulating effects of fluid film, film coefficients, and overall heat transfer coefficient U.

Applications of Fourier's law to conduction through flat composite walls and to curved surfaces with fluid films.

Insulation of buildings, pipework and furnaces.

Descriptive treatment of heat exchangers, evaporators, condensers, coolers, boilers, and of convective and radiant heat transfer in furnaces and ovens.

3.1.3 Fuels and Combustion (13 hours)

Subject Matter

The world energy situation, predictions for the future.

Revision of Dalton's law, Avogadro's law, and molar quantities as applied to gas mixtures.

Fuels: classifications, analyses, higher and lower calorific values. Principles relating to efficient combustion; fuel and air mixing, optimization of excess air, relationship between combustion, time and temperature.

Stoichiometry; determination of stoichiometric air to fuel ratios for solid liquid and gaseous fuels. Excess air. Calculation of excess air from dry products analysis. Determination of heat loss in exhaust products.

3.2 Fluid Mechanic I

3.2.1 Fluid Statics (8 hours)

Subject Matter

Definition of a fluid; properties of fluids: density. Relative density, specific weight, surface tension. Units.

Pressure at a point; absolute and gauge pressure, variation of pressure with depth, pressure head.

Hydraulic pressure applications, hydraulic cylinders and jacks.

Measurement of pressure; barometer, piezometer, U – tube manometers, Bourdon gauge.

3.2.2 Fluid Dynamics and Flow Measurement (10 hours)

Subject Matter

Equation of continuity of flow, energy of fluids, Bernoulli's energy equation, applications, syphons.

Flow measurement; sharp edged orifice, Pitot tube, venturimeters, notches, anemometers, and industrial meters.

3.2.3 Dimensional Analysis and Dynamical Similarity (6 hours)

Subject Matter

Dimensional homogeneity, Rayleigh method of analysis, application to resistance of totally and partially submerged bodies, Stoke's law, testing of models.

3.2.4 Fluid Friction and Flow (9 hours)

Subject Matter

Definition and units of viscosity.

Reynold's experiments; laminar and turbulent flow.

Significance of Reynold's number, transitional flow.

Laminar flow; Poiseuille equation, estimation of viscous loss in journal and collar bearings.

Turbulent flow; Darcy equation.

Effect of surface roughness, friction coefficients, and variation with Reynold's number.

3.2.5 Fundamentals of Lubrication (Tribology) (12 hours)

Subject Matter

Friction; resistance to motion, sliding and rolling friction, generation of heat, loss of energy, effects of temperature.

Wear; destruction and loss of surface material, effects of speed and temperature on wear effects of dirt.

Lubrication; function of lubricants, reduction of wear and friction, cooling, general description of hydrodynamics, thin film and boundary layer lubrication.

Power losses in bearing; journal and collar types.

Selection of lubricants; properties of greases and oils, oxidation stability, acidity, emulsification, pour point, viscosity, thermal conductivity and specific heat.

Factors governing selection; application to journal and slider, gears and roller bearings; operating conditions, economic considerations.

3.3 Electrical Technology I

3.3.1 DC Circuit Theory (8 hours)

Subject Matter

Definition of emf and potential difference;

Ohm's law applied to a circuit with pure resistance, e.g. potential divider circuit and Wheatstone bridge.

Elementary treatment of Kirchhoff laws.

Applications in circuits with more than one source of emf.

Applications in Wheatstone bridge circuits.

3.3.2 Magnetic Circuit Theory (12 hours)

Subject Matter

Description and definition of the terms mmf, reluctance, flux density, magnetic induction.

Constant and relative permeability.

Composite circuits neglecting leakage/fringing.

Prediction of mmf required to set up given flux/flux density in air gap of a composite circuit.

Magnetic pull between two surfaces.

Lifting magnets.

3.3.3 Time Response of Circuits (6 hours)

Subject Matter

Relationship between charge, voltage and capacitance ($V = {}^{Q}/_{C}$).

Constant and relative permittivity.

Self and mutual inductance of coils.

Time constant of capacitive/resistive circuits, and their application in timing devices.

3.3.4 AC Circuit Theory (12 hours)

Subject Matter

Mean, peak rms values of sinusoidal voltages/currents and their relationship. AC voltage and current in pure ohmic resistance, capacitance, inductance. Phasor diagrams applied to LC, LR and LCR series and parallel circuits.

Power factor, definition in terms of:

I) Power consumed = apparent power × power factor

II) Phase difference between voltage and current, i.e. cos∅.

Correction of power factor using parallel capacitor.

Definition of resonance.

Voltage magnification at resonance.

J operator for addition and subtraction of voltage/current phasors, and impedance.

3.3.5 Transformer (8 hours)

Subject Matter

Transformer construction and emf equation.

Energy losses associated with heating, hysteresis, eddy currents.VA rating. Calculations based on efficiency, load currents.

Use with bridge rectifier to provide dc supply.

Open and short circuit tests for calculating efficiency.

3.3.6 Electrical Measuring Instruments (14 hours)

Subject Matter

Moving coil voltmeter, ammeter, ohmmeter, wattmeter.

Range and accuracy. Time base recorders; chart recorders; cathode ray oscilloscope.

Use of CRO as instrument to measure frequency, voltage and phase.

Use of CRO as X/Y recorder.

3.4 Properties of Materials I

3.4.1 Structure of Materials (10 hours)

Subject Matter

A brief descriptive treatment of atomic bonding, ionic, covalent and metallic bonding as well as secondary bonding.

To consider briefly the structures of metals, polymers and ceramics and to show how they affect the material's properties.

3.4.2 Mechanical Testing (6 hours)

Subject Matter

A descriptive treatment of the tensile, impact and hardness tests, wherever possible using practical demonstrations.

Interpreting the test results and showing how they can be used in engineering design.

3.4.3 Solidification of Metals and Alloying (12 hours)

Subject Matter

Formation of equilibrium diagrams using simple cooling curves for different alloy systems. Show how the cooling curves are analyzed using the lever rule and how they are used to predict the phases that exist for a particular alloy at different temperatures. Consider how precipitation and super saturation occur and how they can lead to hardening processes.

3.4.4 Defects in Crystal Structure (12 hours)

Subject Matter

A descriptive approach to consider the different types of defects present in a metal crystal, concentrating on the edge dislocation when considering line defects.

3.4.5 Deformation (6 hours)

Subject Matter

A brief consideration of the movement of ions under stress and how dislocation movement leads to plastic deformation.

3.5 Strength of Materials I

3.5.1 Stress and Strain (20 hours)

Subject Matter

Direct stress, direct strain, tensile loads, compressive loads, sign convention, Hook's law, modulus of elasticity, load extension graph, stress – strain graph, complete load – extension diagram for mild steel, tensile test results, brittle and ductile materials. Strain energy in simple tension or compression, compound bars, temperature stresses, shear stress, shear strain, modulus of rigidity, complementary shear stress, strain energy in simple shear, riveted joints.

3.5.2 Shearing Force and Bending Moment (12 hours)

Subject Matter

Definition of beams, types of support, types of loads, definition of shearing force, calculation of shearing force, sign convention, shearing force diagram, definition of bending moment, sign convention, bending moment diagram, relationship between load shearing force and bending moment, points of inflection.

3.5.3 Properties of Area (8 hours)

Subject Matter

Definition of centroid of a lamina, first moment of area and second moment of area, parallel axes theorem, perpendicular axes theorem.

3.6 Applied Mechanics I

3.6.1 Statics (12 hours)

Subject Matter

Definition of vector quantities, addition and subtraction of vectors, resolution of vectors. The concept of force, the moment of a force, conditions of equilibrium for coplanar forces. Free body diagrams. The polygon of forces. The center of gravity of a body, the center of area of a lamina. Simple frameworks, forces acting on a pin – joint, forces acting on a member, the graphical solution, the analytical solution.

3.6.2 Friction (8 hours)

Subject Matter

Definition of friction, laws of friction, angle of friction, coefficient of friction, kinetic friction, static friction, friction on an inclined plane, application to screw threads.

3.6.3 Kinematics of Rigid Bodies (5 hours)

Subject Matter

Linear displacement, velocity and acceleration.

Angular displacement, velocity and acceleration.

Formulae for constant acceleration with linear and angular motion, relation between linear and angular motion.

3.6.4 Kinetics of Rigid Bodies (Translatory Motion) (15 hours)

Subject Matter

Linear momentum, Newton's laws of motion, equation of motion, gravitational force on a body, work done by a constant force, work done by a variable force, energy and power, kinetic energy of translation, linear impulse, conservation of linear, momentum, impact, loss of energy due to impact, translation in a circular path.

3.7 Mathematics and Computing I

3.7.1 Calculus (40 hours)

Subject Matter

Review of differentiation, interpretation and the derivatives of simple algebraic, trigonometric, exponential and logarithmic expressions. Differentiation of sums, products, quotients, and functions of functions. Implicit and parametric differentiation. Second and higher derivatives. Maxima and minima.

Review of integration, indefinite and definite integrals. Integration of algebraic, trigonometric and exponential functions. Integration by substitution, by partial fractions, and by parts. Numerical method of integration. Calculation of areas, volume of revolution, first and second moments.

Parallel and perpendicular axes theorems.

3.7.2 Algebra (35 hours)

Subject Matter

Introduction to complex numbers, addition and subtraction, Argand diagram representation. Multiplication and division, modulus/argument form, exponential form, DeMoivre's theorem and applications.

Iterative methods of solving algebraic equations, convergence and divergence, Newton – Raphson method, application to solution of equations derived from engineering problems.

Introduction to matrices in two dimensions, addition, multiplication and inverse. Solution to simultaneous equations in two variables, extension to three dimensions, determinants.

Binomial and exponential series expansions, partial fractions.

Cartesian coordinates equations of straight lines, circles, ellipse, hyperbola and parabola. Polar coordinates.

3.7.3 Probability and Statistics (15 hours)

Subject Matter

Introduction to probability, events and their Boolean algebras. Mutually exclusive and independent events and their probabilities. Conditional probability, Baye's theorem. Uniform, binomial and Poisson probability laws and their areas of application.

Descriptive statistics, discrete and continuous data, grouping of data, representation as bar charts and ogives.

Measures of location and spread, calculation of sample mean and sample standard deviation for grouped and ungrouped data.

3.8 Manufacturing Processes I

3.8.1 Primary Processes (51 hours)

Subject Matter

3.8.1.1 Casting (14 hours)

Fundamentals involved in the manufacture of metallic components from the liquid state by sand casting, die-casting, investment casting and shell molding.

Materials suitable for each casting process.

Mold construction for these processes.

Compare the types of materials, soundness of casting, complexity of design, manufacturing quality, quantities required and overall manufacturing costs.

3.8.1.2 Hot and Cold Forming (thick section) (8 hours)

Fundamentals involved in rolling, forging, extrusion and wire drawing ofmetallic components.

Effect on physical properties, defect.

3.8.1.3 Plastics (5 hours)

Difference between thermoplastics and thermosets.

Form of supply of plastic materials. Injection molding, compression molding, transfer molding.

Mold configuration. Presses used in plastic molding.

3.8.1.4 Sintering (4 hours)

Fundamentals involved in the manufacture of components from metallic and non – metallic powders.

Compare properties of sintered and more conventional components. Pressing principles used. Volume ratio.

Sintering processes, post-sintering processes.

3.8.1.5 Shearing and Forming (8 hours)

Principles of piercing, blanking, cropping and bending of sheet metal. Construction of a press tool.

Types of presses. Mechanical, hydraulic; single, double and triple action. Closed and open frame. Force calculation. Use of shear.

Principles of metal spinning and flow turning.

Typical applications.

3.8.1.6 Welding Processes (12 hours)

Oxy – acetylene gas welding characteristics of welding gases, welding equipment, applications and welding procedures.

Manual metal (shielded metal), arc welding: fundamentals of the process, equipment, materials, applications, joint design and preparation, welding procedure and weld quality.

3.8.2 Machining (25 hours)

Subject Matter

3.8.2.1 Generation of Flat Surfaces (6 hours)

Principles of generating flat surfaces.

Construction of machine tools for milling, surface grinding, shaping.

3.8.2.2 Generation of Cylindrical Surfaces (6 hours)

Principles of generating cylindrical surfaces.

Construction of machine tools for turning, drilling, boring.

3.8.2.3 Metal Cutting (4 hours)

Basic principles of metal cutting. Effect of rake and clearance.

Single point cutting tools, orthogonal and oblique cutting.

Drill geometry, milling cutters.

3.8.2.4 Cutting Tool Materials (2 hours)

Development of materials up to modern coated carbides.

Form of supply of tool materials.

Method of supporting and clamping cutting tips.

3.8.2.5 Cutting Fluids (1 hour)

Types of cutting fluids, synthetic fluids, chemical solutions, lubricants, application of cutting fluids.

3.8.2.6 Tool and Cutter Grinding (2 hours)

Construction of tool and cutter grinding machines.

Work support, tooth rest, offset calculations.

Applications to plain milling cutters, form relieved milling cutters, inserted tooth face milling cutters.

3.8.2.7 Process Planning and Costing (4 hours)

Exercises in planning machining sequences for milled, turned, bored, etc. components and estimation of the manufacturing cost.

3.8.3 Metrology (14 hours)

Subject Matter

3.8.3.1 Linear Measurement (6 hours)

Standards of length; line and end standards.

Use of slip gauges. Principle of micrometer and Vernier scales and instruments.

3.8.3.2 Angular Measurement (4 hours)

Vernier protractor, angle slip gauges, angle dekkor, sign bar. Use of balls and rollers.

3.8.3.3 Measurement of Flatness (4 hours)

Precision level, application for measuring a surface table.

3.9 Engineering Drawing and Design I

3.9.1 Line, Lettering and Scale (20 hours)

Subject Matter

Lines: various line symbols, centerline, visible line, hidden line, dimension lines, section lines.

Lettering: various styles of lettering, legible lettering numbers.

Scale: full size, reduced or enlarged proportion, standard metric scaling system.

3.9.2 Projections (30 hours)

Subject Matter

Orthographic projection: examples of first and third angle projections, position of views.

Pictorial projection: examples of isometric projections, isometric scale, example of oblique parallel projection.

Sections: full sections, half sections, offset sections, hidden and visible lines in sectional views, broken out sections, revolved sections, sections through shafts, bolt, rivets, etc.

Examples of sections of isometric and oblique projections.

3.9.3 Cams and Linkage (25 hours)

Subject Matter

Cams: kinds of cams, types of followers, common types of motion produced by cams, uniform motion, S.H.M., constant acceleration, displacement diagrams, cam curve.

Linkage: examples of simple mechanisms, 4 – link mechanism, quick return mechanism, loci of point.

3.9.4 Interpenetration (Intersection) of Surfaces (25 hours)

Subject Matter

Examples of intersecting prisms, cylinders, intersecting cylinders and prisms, cylinders and cones, intersection of planes and curved surfaces.

3.9.5 Development (25 hours)

Subject Matter

Pattern layout for fold up packages, development of prisms, oblique prisms, development of cylinders, oblique cylinders, four-piece elbow. Pyramids and cones, true length of an edge of a pyramid or an element of a cone, method of triangulation, development of a transition piece, development of shapes intersecting with each other.

3.9.6 Technical Drawing (25 hours)

Subject Matter

Screws, screw thread, screw thread profiles, bolts, studs, various bolt heads, nuts (thread series for unified and American National screw thread).

Examples of locking devices for nuts, keys cottered joints.

Rivets fittings and joints, valves, elbows, union plugs, tee, cap.

3.9.7 Dimensioning (30 hours)

Subject Matter

Dimensioning: functional dimensioning, projection lines, dimension lines, leaders.

Linear dimensioning, angular dimensioning, arrangement of dimensions.

Tolerance dimensions: general tolerance block, tolerancing of angular dimensions, cumulative effects of tolerance.

Geometrical tolerancing; importance of maximum metal condition, interpretation of straightness, flatness, parallelism, squareness, angularity, concentricity, symmetry and position.

Virtual size, datum faces.

Surface finish.

Limits and fits: terminology and definitions, determination of fit, selection of holes and shafts using ISO tables. Significance of maximum and minimum metal conditions.

3.9.8 References

1. Engineering Drawing with Worked Examples (Parts 1 and 2), Pickup and Parker (Hutchinson Education).

2. Technical Drawing, D.F. Morris, (Thomas Nelson and Sons ltd).

3. Basic Engineering Drawing, R.S. Rhodes and L.B. Cook (Pitman).

4. Graphics for Engineers, R.P. Hoelscher (John Wiley and Sons Inc.).

5. Machine Drawing and Design, W. Abbott (Blackie).

6. Manual of British Standards in Engineering Drawing (B.S.I.).

3.10 Technical English I (90 hours)

Subject Matter

3.10.1 Skills

3.10.1.1 Reading:

Study of different techniques in reading.

Definition of purpose in reading and the speeds and techniques suited to different purposes.

Speed-reading.

Skimming to find the subject of a passage.

Definition of the subject of a passage.

Scanning to find the relevant part of a passage or for specific information.

Levels of generality.

Relations between generalizations and examples.

Information transfer to tables and diagrams.

Deduction of information from the passage.

Deduction of word meaning from the passage.

Prediction of what will come next in a passage.

Recognition of the functions of a passage, e.g. definition, classification.

Cohension – what words such as the words e.g. they, the former, refer to.

Note taking.

3.10.1.2 Writing:

Long – term goal – training report (to be submitted during training).

Instructions.

Definitions of properties.

Definitions of objects, processes and materials.

Paragraphs describing a) structure, b) processes, c) cause and effect.

Paragraphs classifying objects, materials and processes.

Each function should have an appropriate paragraph writing exercise.

3.10.1.3 Reference:

Use of the Latin alphabet as an ordering device so that students can spot words that are out of order in a list and use dictionaries and indexes at speed.

Use of English – English dictionaries.

Use of English – Arabic dictionaries.

Use of book indexes and contents pages.

Use of the library and the library index and catalogue.

3.10.1.4 Listening:

Dictation – paragraphs for which the student has a incomplete written version.

Completing tables and diagrams for oral description.

Recognition of the subject of an oral text.

Completing notes from oral sources.

3.10.2 Functions

3.10.2.1 Static Description:

Properties

Location

Structure

Classification

Definition of properties of objects

Measurement

Quantification of properties of materials

Function and ability

Cause and effect.

3.10.2.2 Description of processes:

Cause and effect.

Instructions.

3.10.3 Linguistic Features

1. Verbs be and have
2. Number
3. The present simple tense active (with number negative and question forms).
4. The present simple passive (with number negative and question forms).
5. Article systems.
6. Adverbials.
7. Paragraph structure, including cohesion and logical connectors such as therefore, because, etc.
8. Relative clauses with which, where, from which, through which, etc.
9. Preposition of location and direction.
10. Verb infinitive forms; pre + verb ing e.g. by/for igniting …
11. Verbs with clausal complements such as cause, enable, prevent.

3.10.4 Tasks

Writing a report on training.

Library reference work.

Keeping a vocabulary notebook.

3.11 Workshop Practice I and II (720 hours)

Subject Matter

3.11.1 Electrical Installation I and II (124 hours)

1. Correct standards on wiring/installation, e.g. covering on wire PTFE or PVC.

2. Correct number of conductors for current capacity with a safety factor.

3. Specification on terminations wiring of single phase plugs.

4. Earthing arrangements, for single-phase supplies.

5. Wiring in trench, under floor or ceilings, labelled, labelling, used of detailed drawings.

6. Use of PYRO (trade name) cable or similar in more hazardous situations, e.g. water, heat, etc.

7. Color codes of resistors and capacitors.

8. Standards and specifications of other electronic components such as transistors and diodes.

9. Limitations of electrical instruments and multimeters.

10. Wire gauge (SWG) and wire sizes.

11. Specification on the termination of 3ph plugs/sockets.

12. STAR and DELTA connections for three phase motors.

13. Earthing arrangements for three-phase supply.

14. Neutral line in a three-phase supply (STAR); non – earthing for unbalanced loads.

15. Operation and care of electrical machines.

16. The connection of and the problems associated with relays and magnetic switches.

17. Methods of repair of electronic circuits, especially simple power circuits.

3.11.1.1 Practical Work I and II

1. Use of multimeters to test for the continuity in equipment and for the verification of Ohm and Kirchhoff's laws.

2. Connection of one lamb to a power supply.

3. Construction of series and parallel circuits.

4. Series/parallel circuits.

5. Switches; two way and intermediate switches.

6. Connection of fluorescent lamps, single, double in parallel and double in series.

7. Connection of office bells including bell indicator sets.

8. House wiring.

9. Inspection of short and open circuit faults.

10. Winding of single-phase transformers and coils.

11. Joints; tee, married and Britannia.

12. Soldering; cable soldering, electronic components soldering.

13. Measurement of voltage, current and power.

14. Installation of simple electronic circuits, e.g. power supply circuits, voltage regulators, etc.

3.11.1.2 Safety

A) Correct fusing, installation, use of NEON indicators to show when live is applied.

B) Switches always be placed in live lines.

C) Treatment of electric shock.

D) Euro standard.

E) High voltage precautions.

3.11.1.3 Practical Experience

Additionally the student must have a practical experience in the testing, installation and repair of the following electrical and electronic components and systems:

1. Power Distribution Systems.

2. Electric Machines:

Generators: AC, DC and synchronous.

Motors:

DC motors (including shunt, series and compound).

AC motors: split phase, shaded pool, repulsion and capacitor types, rotary magnetic field induction motors, and synchronous motors.

3. Controls:

Relays; manual, current and voltage.

Magnetic switches; drum, reversing switch.

4. Solid State:

Power circuits using metal rectifiers and Zenner diodes.

Operational amplifiers.

Assembly of circuits on electronic circuit boards.

3.11.2 Machining I and II (124 hours)

Safety aspects of center lathe operation. The principles of the center lathe and its method of operation. Preparation of work for turning between centers, use of three – point steady to ensure accurate centering. Turning multi – diameter work to close limits. Truing of headstock center. Use of three and four jaw chucks for work requiring external turning and internal boring and reaming operations.

Screw cutting, single and multi – start screw threads, internal and external and assembly of internally and externally threaded components. Use of chasing dial. Taper turning, the turning of tapers using tailstock, compound slide and taper turning attachment.

Use of taps and dies for screw threads manufacture and the assembly of externally and internally threaded components.

3.11.2.1 Shaping

Setting of the shaping machine for the manufacture of flat surfaces which may be parallel, inclined or perpendicular to each other. The machining of grooves and tee – slots.

3.11.2.2Milling

Setting of the milling machine and cutter selection for the machinery of flat surface which are either parallel inclined or perpendicular to each other. The machining of grooves and Tee – slots.

3.11.2.3 Grinding

Use of the tool and cutter grinder for grinding work pieces such as lathe mandrels and other work which requires grinding between centers.

The use of the hand or cutter grinder for the sharpening of all types of lathe and shaper tools.

3.11.3 Foundry Work I and II (124 hours)

Safety aspects of foundry work, foundry equipment and machines.

Sand preparation, mold casting and fettling operations.

Study of the design of different types of pattern; allowances (machining and shrinkage) for the preparation of molds.

The effect of gates, runner and riser positions and shapes.

Cupola and Crucible furnaces for melting cast iron, Aluminium and copper alloys (or any nonferrous metals available).

Gravity die-casting molds.

3.11.4 Forging I and II (45 hours)

Safety aspects of the forging shop. Forging equipment and tools, forging hearths. Heating of work piece. Hot and cold cutting of work pieces using chisels.

Heat treatment of carbon and alloy steels. Quenching media. Surface hardening using carbonizing powders.

The practical exercises in this shop should be directed towards manufacturing a range of hand tools.

3.11.5 Elementary Carpentry and Pattern Making I and II (45 hours)

Planing of wood: types of plane; jackplane, smoothing plane, form planes, machine planes.

Saws: types – rough, cross cut, tenon, fretsaw, circular saw.

Chisels: types – flat, beveled, form.

Sharpening of planes, chisels and saws.

Wood joints: types of joint used in pattern making.

Manufacture of simple patterns; removing angle, shrinkage and machining allowance.

Tool sharpening.

3.11.6 Bench Work I and II (45 hours)

Safety aspects of bench work and fitting.

The types of files available and their applications; marking out tools, taps, dies and drills.

The use of different fitting tools to enable the student to gain skills in bench work.

Filing, drilling, tapping, riveting and assembly.

Use of surface plate, squares, scribers, rules and other measuring equipment; marking out operations.

Note: it is suggested that this section of the course be used to manufacture a range of hand tools.

3.11.7 Elementary Welding Practice I and II (45 hours)

3.11.7.1 Gas welding:

Safety aspects; setting gas welding apparatus, leakage testing, flame adjustment. Creating and controlling a molten pool, introduction of filler rod to molten pool.

Running short and long stringer beads in flat position.

Use of weaving techniques.

3.11.7.1 Arc Welding:

Techniques of arc welding. Correct connection of welding circuit, setting of welding machine variables. Arc striking and arc length control. Running of short and long stringer beads in flat position.

Use of weaving techniques.

Welding of mild steel gauge plates by both oxy – acetylene and manual arc methods. Joints; closed corner and open corner, confined to flat position and leftward welding techniques.

3.11.8 Welding and Joining of Metals I and II (82 hours)

Preparation of work pieces.

Correct setting and adjusting of welding plant to obtain optimum welding conditions.

Welding of components by both oxy – acetylene and electric arc methods involving all basic joints (confined to down hand-welding techniques).

Welding of various metals, steels, cast iron, Aluminium and Aluminium alloys, building up fillet welds.

Repair work.

Flame cutting, flame adjustment, preheating, cutting.

Arc cutting, stock arc, carbon arc.

Visual inspection and workshop testing of welds

3.11.9 Engine Components and Analysis I and II (86 hours)

Identification of petrol and diesel engine types.

Identification of major components; block, piston, conrod, crankshaft, camshaft, lubrication and water pumps, cooling system, dynamo/alternator, diesel pump and injector, petrol spark plugs and ignition systems and carburation, exhaust systems.

Dismantling and assembly of main engine block and the removal, testing and replacement of ancillary equipment.

Testing the rebuilt components and the engine.

Chapter Four

Syllabuses of the Second Year Diploma Course

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

4.1 Thermodynamics II (45 hours)

4.1.1 Second Law of Thermodynamics (8 hours)

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.

4.1.2 Internal Combustion Engines (18 hours)

Subject Matter

Description of S.I. and C.I. Engines.

Operation and control of 4 stroke and 2 stroke 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.

4.1.3 Air Compressors (8 hours)

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.

4.1.4 Psychrometry (11 hours)

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.

4.1.5 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.

4.2 Fluid Mechanics II (45 hours)

4.2.1 Hydrostatics and Buoyancy (8 hours)

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.

4.2.2 Liquids in Relative Equilibrium (6 hours)

Subject Matter

Flow in a curved path.

Liquids subjected to translatory motion free and forced vortices.

4.2.3 Pipe Flow and Power Transmission (15 hours)

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.

4.2.4 Storage Reservoirs (8 hours)

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.

4.2.5 Fluid Machinery (8 hours)

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.

4.2.6 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.

4.3 Electrical Technology II (60 hours)

4.3.1 Three Phase Supplies and Associated circuitry (10 hours)

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.

4.3.2 Electrical Rotating Machines (17 hours)

Subject Matter

Equations of performance for dc/shunt, series and compound generators and motors.

Equations of the type $E = K\emptyset n$, $T = K\emptyset Ia$, $V = E + IaRa$.

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.

4.3.3 Control of Electrical Power, Electrical Machines (15 hours)

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, on line 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.

4.3.4 Electronics (12 hours)

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.

4.3.5 Industrial Electronics (6 hours)

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.

4.3.6 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.

4.4 Properties of Materials II (50 hours)

4.4.1 Ferrous Alloys (10 hours)

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.

4.4.1.1 Steels (8 hours)

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.

4.4.1.2 Cast Irons (5 hours)

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.

4.4.2 Non - Ferrous Alloys (6 hours)

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.

4.4.3 Polymers (11 hours)

Subject Matter

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

4.4.4 Ceramics (5 hours)

Subject Matter

A brief description of the structure and properties of ceramic materials.

4.4.5 Composite Materials (5 hours)

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.

4.4.6 References

1. Materials science for engineers, Van Vlack L.C., pub: Addison – Wesley 1980.

2. Engineering Materials, Ashby M.F., Jones D.R.H., pub: Pergamon 1980.

3. Metallurgy for Engineers, Rollason E.C., pub: Arnold 1973.

4.5 Strength of Materials II (50 hours)

4.5.1 Simple Bending of Beams (10 hours)

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.

4.5.2 Torsion of Circular Shafts (8 hours)

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.

4.5.3 Axial Stress in Unsymmetrical Loading (12 hours)

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.

4.5.4 Analysis of Stress and Strain at a point (20 hours)

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.

4.5.5 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.

4.6 Engineering Dynamics II (50 hours)

4.6.1 Kinetics of Rigid Bodies (Angular Motion) (20 hours)

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.

4.6.2 Simple Harmonic Motion (15 hours)

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)

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.

4.6.4 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".

4.7 Mathematics and Computing II (90 hours)

4.7.1 Calculus (40 hours)

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.

4.7.2 Probability and Statistics (30 hours)

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.

4.7.3 Advanced Mathematics (15 hours)

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.

4.7.4 Further Topics

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

Subject Matter

Eigenvalues and eigenvectors, characteristic equation.

Application to mechanics.

4.7.5 Computing (15 hours)

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.

4.7.6 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.

4.8 Manufacturing Processes II (90 hours)

4.8.1 Machining (40 hours)

Subject Matter

4.8.1.1 Copying and Generating (4 hours)

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

4.8.1.2 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.

4.8.1.3 Special Milling Processes (6 hours)

Operating principle of the dividing head.

Differential indexing. Use of dividing head for helical milling and cam milling.

4.8.1.4 Form Tools (2 hours)

Types (flat, tangential, circular), with and without rake, design of form tool. Tool holders.

4.8.1.5 Broaching (3 hours)

Features and broach nomenclature, puller, broaching machines, types of operation, classification of broaches.

4.8.1.6 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.

4.8.1.7 Special Machining Processes (8 hours)

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

Application of the above processes.

4.8.2 Joining Processes (27 hours)

Subject Matter

4.8.2.1 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.

4.8.2.2 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.

4.8.2.3 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.

4.8.3 Metrology (23 hours)

Subject Matter

4.8.3.1 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.

4.8.3.2 Comparators (12 hours)

Types, methods of magnification.

Principles of mechanical, mechanical – optical, pneumatic, electrical, fluid displacement comparators.

3.3 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.

4.8.4 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).

4.9 Engineering Drawing and Design II (180 hours)

4.9.1 Design Process (50 hours)

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.

4.9.2 Design for Strength (50 hours)

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.

4.9.3 Power Transmission (80 hours)

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.

4.10 Technical English II (60 hours)

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.

Chapter Five

Syllabuses of the Third Year Diploma Course

The following matter covers the subjects' content of the third year of the diploma course in mechanical engineering for both power and production engineering options.

5.1 Common Core Subjects for Mechanical Engineering Power Option and Production Engineering Option

5.1.1 Properties of Materials (42 hours)

5.1.1.1 Method of Failure in Service (hours)

5.1.1.1.1 Fracture

Subject Matter

Types of fracture, fast fracture, stress intensity and fracture toughness.

Notch effects, temperature, ductile/brittle transition.

Effect of alloying on the transition.

5.1.1.1.2 Fatigue and Creep

Subject Matter

Fatigue fracture; recognition and definition tests, S/N curves for ferrous and non – ferrous materials, fatigue and endurance limits.

Creep; failure, tests, effect of load and temperature, minimum creep rate, life predictions.

Creep and fatigue resistance materials.

5.1.1.1.3 Wear

Subject Matter

Surface finish and arc of contact, relation to friction and wear.

Surface finish and arc of contact, relation to friction and wear.

Adhesive and abrasive wear.

Effect of lubrication on friction and wear.

Selection of materials and lubricants.

5.1.1.1.4 Corrosion (18 hours)

Subject Matter

A descriptive approach to the mechanisms of failure, how the test data can be analyzed and used in design studies.

5.1.1.2 Selection of Materials (24 hours)

Subject Matter

The basic concepts of materials selection are discussed and illustrated with the aid of case studies.

Selection of materials for manufacture by casting, machining, hot and cold working, welding, soldering and brazing.

5.1.2 Strength of Materials (48 hours)

5.1.2.1 Deflection of Beams (10 hours)

Subject Matter

Moment curvature relationship, Macaulay's method, deflection in simply supported beams and cantilevers using Macaulay's method, deflection in built – in beams using Macaulay's method.

5.1.2.2 Struts (5 hours)

Subject Matter

Definition of struts, pin – ended strut, strut with fixed ends; partial fixing of the ends, strut fixed at one end and pinned at the other, strut with eccentric load, limitation of Euler theory, Rankine formula.

5.1.2.3 Cylinders (9 hours)

Subject Matter

Thin cylinders under internal pressure, thin spherical shell under internal pressure, cylindrical shell with hemispherical ends, volumetric strain on capacity, tube under combined loading, thick cylinders under internal and external pressures, thick cylinders under internal pressure only, plastic yielding of thick tubes, compound tubes, hub shrunk on solid shaft, thick spherical shells.

5.1.2.4 Shear Stresses in Beams (6 hours)

Subject Matter

Variations of shear stress in beams, rectangular section, I – section, shear center, shear flow, shear strength of welds, rivets and bolts, closed thin walled sections subjected to torsion, open sections composed of rectangular elements.

5.1.2.5 Stress Analysis Application (6 hours)

Subject Matter

5.1.2.5.1 Stress Analysis in Rings

Stresses in bars of small initial curvature.

Stresses in split rings.

5.1.2.5.2 Rotating Discs

Stresses in disc of uniform thickness, solid disc, disc with central hole.

5.1.2.5.3 Springs

Stress and deflection in closed – coiled helical springs, stress and deflection in semi – elliptic and quarter – elliptic leaf springs.

5.1.2.6 Experimental Stress Analysis (12 hours)

Subject Matter

Purpose of experimental stress analysis, simplification of the problem and summary of the method of E.S.A., special families of curves, basic principles of the strain gauge, types of gauge, basic bridge circuit theory, full equations for the Wheatstone bridge. Photo – elasticity, basic optics, and photo – elastic materials, optical systems (plane polariscopic, circular polariscopic), fringe patterns, practical results, applications of photo – elasticity, measurement of fringe orders, separation of principal stresses.

5.1.2.7 References

1. Crandall, Dahl and Lardner. An Introduction to Mechanics of Solids.

2. James W. Dally and William F. Riley. Experimental Stress Analysis.

3. G. H. Ryder. Strength of Materials.

4. S. Timoshenko. Elements of Strength of Materials.

5. S. A. Urry and P. J. Turner. Solution of Problems in Strength of Materials and Mechanics of Solids.

6. Van Vlack L. C. Materials Science for Engineers. Addison – Wesley, 1980.

7. Ashby M. F., Jones D. R. H., Engineering Materials, Pergamon, 1980.

8. Rollason E. C., Metallurgy for Engineers, Arnold, 1973.

5.1.3 Engineering Dynamics, Control and Instrumentation

5.1.3.1 Dynamics (45 hours)

Subject Matter

A) Crank Effort Diagrams (7 hours)

Crank effort diagrams, fluctuation of speed and energy, flywheels.

Description of governors.

B) Balancing (7 hours)

Balancing of rotating masses, single out of balance mass, several out of balance masses in one plane, inertia force on a reciprocating mass, primary and secondary balancing, balancing of a single reciprocating mass.

C) Geared Systems (10 hours)

Velocity ratio, power transmission by gears, torque/acceleration relationships, simple and compound gear trains, epicycle gear trains, simple epicycle gear trains, torque on epicycle gears.

D) Vibrations (21 hours)

Free vibrations, single degree of freedom, undamped system, linear and torsional vibrations, resonance, damped systems with linear and torsional vibrations. Two degrees of freedom, undamped system, linear and torsional vibrations. Problems in free vibrations. Forced vibrations single degree of freedom, undamped systems with linear and torsional vibrations, problems in forced vibrations. Practical problems related to the vibration of shafts, machine tools and engines; methods of reducing vibration, isolation of vibrating parts.

5.1.3.2 Control and Instrumentation (45 hours)

Subject Matter

A) Control Systems (24 hours)

Mathematical model. Transfer function. Open and closed loop system block diagram representation. Time response of system to step, ramp and sinusoidal inputs. Time delay.

Stability of closed loop system from open loop frequency response: Bode and Nyquist diagrams. Gain and phase margins.

Performance criteria and error minimization.

Performance improvement by compensation.

Application of above techniques to practical system e.g. position, pressure, temperature and flow control.

B) Instrumentation (21 hours)

Definition of an instrument, actuator and transducer.

Analogue and digital instruments. Spring, lever, bridge circuit, flapper valve. Force and torque measurement; load cells, balances.

Temperature measurement: thermometers, thermocouples, pyrometers, thermistor. Vibration measurement; read vibrometer, strain gauges. Displacement measurement L.V.D.T. Potentiometer.

Velocity and acceleration measurement.

Flow measurement; Pitot tube, manometers, Bourdon gauge.

Position and level measurement; sight gauges, floats, potentiometers.

Valves: hydraulic and pneumatic systems, accumulation and unloading valves, D.P. regulators, PRV, safety valve, flow control valves, spool valves and their use in steering system, servo operated valves.

Recorders and display units: chart recorders, C.R.O.

Alarms. Control actions, proportional, integral, derivative.

Case studies.

5.1.3.3 References

1. Engineering Instrumentation and Control IV, L. F. Adams, Hodder and Stoughton.

2. Control Engineering, N. Morris, McGraw Hill.

3. Engineering Instrumentation and Control IV, Haslam, Summers and Williams. Arnold.

4. Engineering Instrumentation and Control IV, H. B. Sutton. Butterworth.

5. Modern Control Theory, Schaum's outline series (Control), Oghatta.

6. Mechanics of Machines, John Hannah.

7. Open University Series (T. 291), (Instrumentation), Units 1 – 13.

8. Engineering Mechanics – Second Vector Edition, Volume II, Dynamics, Archie Higdon, William B. Stiles, Arthur W. Davis, Charles B. Evces.

9. Applied Mechanics – Metric Edition, J. Hannah, M. J. Hillier.

10. An Introduction to the Principles of Vibration of Linear Systems, Pierre Thureau and Daniel Lecter. Translated by J. Grosjeau.

11. Theory of Vibration with Applications, William T. Thomson.

5.1.4 Organization of Engineering Projects (90 hours)

5.1.4.1 Management and Organization (9hours)

Subject Matter

The function of management.

The various types of business organization.

The nature of authority and responsibility.

Relationship between organization structure and objectives.

The need for and problems associated with delegation and the requirement for follow up action. The effects on worker performance of the introduction of change.

The principles of management by objectives applied to controlling projects.

5.1.4.2 Method Study (10 hours)

Subject Matter

The method of process charting.

The principles and practice of time study.

The means of collection and analysis of data.

Means used for management of labor performance.

Using predetermined motion study.

The purpose and design of incentive schemes.

5.1.4.3 Production Costing (12 hours)

Subject Matter

The basic theory of accounting.

Job, process, historical, standard and marginal costing.

Breakeven and profit volume analysis.

Contribution to overall costs of layout material and overheads.

Effects of depreciation. Productivity measures.

5.1.4.4 Plant Location and Layout (16 hours)

Subject Matter

Transport costs. Distribution of networks and accessibility of services.

Availability of resource skills. Types of material handling and costs.

Functional, product, process layouts. Production flow analysis.

Application of ergonomics principles to workplace layout and environment.

Plant layout techniques, cross and relationship chart.

5.1.4.5 Network Analysis (15 hours)

Subject Matter

The uses and meaning of network diagrams.

Definition of the terms: activity, dummy activity, events, nodes.

Determination of earliest and latest event times.

Construction of network diagrams and determination of critical paths.

Use of networks for project planning.

Construction of Ghant charts.

5.1.4.6 Quality Assurance II (10 hours)

Subject Matter

Historic development of quality.

The role of quality in design, quality in manufacture.

Quality control and reliability. The relationship between quality and cost. The objective of a specification.

The effect of design changes on quality.

The system of management to support quality in an organization.

Introduction to reliability theory.

5.1.4.7 Maintenance Management (12 hours)

Subject Matter

The basis for a planned maintenance schedule.

The need to keep accurate history of machine performance.

The reason for a plant register. Design of a maintenance job card.

The need to produce maintenance control reports.

The various types of maintenance, planned, unplanned condition monitoring.

The need for spare part system.

5.1.4.8 Personnel Management (6 hours)

Subject Matter

Need for personnel policy, need for employment. Education, training and management, health, safety and welfare.

Influence of unions. The union movement (in Sudan).

Economic weapons of union, labor law.

Incentive schemes, non – finance incentives, financial incentives, types of schemes, group bonus, supervisory bonus and profit sharing and co – partnership scheme. Wage incentive scheme.

5.1.4.9 References

1. Network analysis, Battersby, Macmillan Press.

2. Maintenance Management, A. Corder, McGraw Hill.

3. Maintenance Planning Control and Documentation, E. N. White, Gower Press.

4. Facility Layout, F. White, Prentice Hall.

5. The Unions, Arnold G. Hamilton, 1981.

6. Work Study, R. M. Currie, 4th Edition, 1977, Pitman.

7. Total Quality Control, Feigharbaum, McGraw Hill.

8. Understanding Organizations, C.B. Handy, 2nd Edition, Penguin.

9. Quality Control Handbook, Juran, 4th Edition, McGraw Hill.

5.1.5 Final Year Projects (180 hours)

Subject Matter

5.1.5.1 Problem Description

A satisfactory explanation of the problem to be solved, mentioning clearly the required output from the project.

Writing specifications, which may be in the form of a word description, or in the form of drawings, or both.

5.1.5.2 Planning and Scheduling

Organizing a plan for solving the problem under consideration:

Identifying the steps, which must be followed.

Estimating the relative times allocated to each step.

Arranging the steps identified in 2.1 into those, which can be performed consecutively, and concurrently and in the order in which they must be performed.

Keeping a logbook in diary form and recording every aspect of the work in compliance with project assessment regulations.

Preparing an initial time chart including all the activities.

5.1.5.3 Research Work

Searching for information relevant to the problem concerned (books, journals, catalogues, etc.).

Looking for previous solutions attempted by other workers or solutions for similar problems.

Selecting the most suitable sources for the particular problem.

5.1.5.4 Alternative Solutions

Looking for existing solutions.

Synthesizing new solutions.

Providing some sketches.

Evaluating all solutions by giving weight to each solution.

Selecting the most suitable solution.

Justifying the selection in 4.5.

5.1.5.5 Analysis and Computation

Using mathematical equations or empirical formulae for obtaining stresses, velocities, accelerations, forces, dimensions, etc.

Models and experiments.

Analysis of experimental results.

5.1.5.6 Experimental Work

The following items must be considered when an experiment is performed.

The objectives of the experiment must be stated very clearly.

Equipment must be specified together with the procedure required for the experimental work.

Analysis of the results.

Conclusions.

Recommendations based on 6.4.

5.1.5.7 Evaluation

To check against the following:

Does the system satisfy all the items of the specifications?

Is the system economically feasible from the manufacturing and marketing points of view?

Outline the change to 7.1 and 7.2 that were found to be necessary during the performance of the project.

Justification of the changes in 7.3.

5.1.5.8 Drawings and Sketches

Sketches, drawings, or both must be provided to support the student's option or decision.

A complete engineering drawing must be attached to the final report.

5.1.5.9 Presentation

Students will be required to produce two copies of the project report in accordance with the format specified in the project regulations.

5.1.5.10 Servicing

The following items must be explained clearly in a form of word description or in the form of drawings or both.

Method of operation.

Control and adjustment for optimization of output.

Failure diagnosis and proper treatment.

Routine maintenance.

Safety precautions.

5.2 Subjects Content of the Third Year Mechanical Engineering Power Option

5.2.1 Design and Integrative Studies (90 hours)

5.2.1.1 Design Concepts (18 hours)

Subject Matter

Standardization: effects of standardization unification on design, production and maintenance costs.

Design factors, cost, performance, safety, reliability etc.

Value analysis method with some examples.

Modelling, types of models, methods of modelling, reasons for modelling.

5.2.1.2 Mechanical Springs (6 hours)

Subject Matter

Types of springs, helical springs, leaved springs, compression springs, tension springs, twisting springs, linear and non – linear springs, stiffness of springs, springs in series, springs in parallel, buckling of springs, materials for springs.

5.2.1.3 Conveyors (9 hours)

Subject Matter

Types of conveyors; belt conveyor, rope conveyors, screw conveyors, buckets conveyor, horizontal, vertical or inclined conveyors.

Calculation of rate of feed and power required for driving conveyors.

Materials for conveyors.

5.2.1.4 Hydraulics (9 hours)

Subject Matter

Hydraulic system components.

Application of hydraulics to various fields.

Forces in vessels and cylinders. Seals and gaskets.

Types of pump, hydraulic motor, valves.

Hydraulic accumulators, connection methods.

Calculation of forces, stroke speed, stroke time flow, pressure; losses.

5.2.1.5 Pneumatics (9 hours)

Subject Matter

Components of a pneumatic system; types of compressors, reciprocating compressors, rotary compressors.

Cylinders, valves, filters.

Use of cylinders for pressing.

Packing and fitting.

Application of pneumatic power for clutches and braking systems.

Safety.

5.2.1.6 Design for Casting (9 hours)

Subject Matter

Introduction of casting processes with regard to size, section, thickness and the prevention of shrinkage and cavity formation.

Design details for easy removal of the pattern from the mold.

5.2.1.7 Projects (30 hours)

Subject Matter

A series of projects of differing nature involving system analysis and using material taught in more than one subject discipline, e.g. –

Water wheel for pumping water.

Windmill for pumping water.

Hydraulic jack for a railway carriage.

Brick making machine.

Plastic extrusion machine.

Spring testing machine.

Two projects of 15 hours = 30 hours

5.2.2 Thermodynamics III (90 hours)

5.2.2.1 Heat Transfer (15 hours)

Subject Matter

Convection; further development of forced and free convection.

Use of dimensionless quantities for the empirical determination of heat transfer coefficients in forced and natural convection. Reynold's analogy.

Radiation: physics of radiation; concept of black body. Plank's law, Wein's displacement law. Stefan – Boltzmann law, radiation functions.

Radiation properties; total radiation properties, Kirchhoff's law, monochromatic radiation.

Concept of a grey body and directional radiation properties.

Radiation shape factor; relative exchange between black surfaces and between grey surfaces.

Combined modes of heat transfer; heat exchangers, parallel, counter and mixed flow. Overall heat transfer coefficients, LMTD calculation of heating surface area for simple heat exchangers.

5.2.2.2 Design of Rotary Machines (12 hours)

Subject Matter

Principle of conversion of enthalpy to KE in rotary machines.

Elementary treatment of gas and vapor nozzles and blades; concept of the choked nozzle, critical pressure ratio, Mach number. Impulse, impulse – reaction and centrifugal blading; explanation of principles and blade types.

5.2.2.3 Refrigeration and Air Conditioning (14 hours)

Subject Matter

Refrigeration plant; descriptive treatment of vapor compression and absorption plant, steam jet, expansion, refrigeration and cooling systems. Refrigeration cycles for vapor compression machines. C.O.P., modifications to basic cycle to raise C.O.P., use of flash chamber and two-stage compression.

Heat pumps.

Air conditioning plant; principles of operation of humidifying coolers and refrigeration type units, calculation of vapor mass and heat transfer rates.

Estimation of operational costs for both types of plant.

5.2.2.4 Gas Turbines (10 hours)

Subject Matter

Descriptive treatment of gas turbines and jet engines.

Theoretical cycles; representation on T – S or P – H axes, calculation of temperatures, air/fuel flow rates for gas turbines operating on the basic cycle. Use of exhaust to air heat exchangers.

Stationary machines; descriptive treatment of the use of jet engines as gas generators, waste heat boilers.

Estimation of power generation costs.

Relative merits and demerits of gas turbine plant.

5.2.2.5 Steam Turbines (10 hours)

Subject Matter

Descriptive treatment of basic steam plant for power generation; boilers, turbines, condensers.

Use of enthalpy/entropy charts for steam.

Practical modified Rankine cycles with superheat and reheat; determination of evaporation and fuel firing rates for a given power output, cycle and overall thermal efficiencies. Importance of condenser vacuum.

Descriptive treatment of regenerative feed heating, use of backpressure turbines for the production of process heat and power.

5.2.2.6 Running of I. C. Engines (9 hours)

Subject Matter

Engine systems; cooling system, lubrication system, air intake system – including supercharging and scavenging – waste heat recovery system, valve gear.

Factors influencing engine performance; combustion in C. I. engines; timing; delay period, normal and knocking combustion, rough operation. S. I. engines; normal and abnormal combustion conditions, detonation, surface ignition, pre – ignition, post – ignition.

Engine reconditioning.

5.2.2.7 Plant Commissioning, Testing and Operating (16 hours)

Subject Matter

Simplification of complex plant diagram; isolation of major items of equipment, identification of control parameters.

Elements of testing; indicator diagrams evaluation of indicated and brake power, m. e. p. , fuel consumption, measurement of heat quantities and fluid flow, analysis of exhaust gases, energy balances; use of energy balance to evaluate energy utilization in engines, furnaces, heating plant, boilers, refrigerators and coolers.

Calculation of fuel quantities and cost. Overall thermal efficiencies. Operational sequences in the startup and load shedding of power generating plants.

5.2.2.8 Alternative Energy Systems (4 hours)

Subject Matter

Brief descriptive treatment of alternative thermal resources; e.g. nuclear fusion/fission, solar geo – thermal, biomass.

The Stirling cycle.

Total energy systems for combined power and process heat generation.

5.2.2.9 References

References for thermodynamics I and II

1. Thermodynamics and Transport Properties of Fluids, S. I. units, Y. R. Mayhew and G. F. C. Rogers, Pub: Basil Blackwell.

2. Applied Thermodynamics for Engineering Technologists, T. D. Eastop and A. McConkey, pub: Longman.

3. Engineering Thermodynamics, Work and Heat Transfer, G. F. C. Rogers and Y. R. Mayhew, Pub: Longman.

4. Thermodynamics, K. Work, Pub: McGraw Hill.

5. Heat Transfer, F. M. White, Pub: Addison Wesley.

6. Heat Engines, R. Joel, Pub: Longmans.

7. Heat Transfer Engineering, H. Schenck, Pub: Longmans.

5.2.3 Fluid Mechanics III (90 hours)

5.2.3.1 Forces Exerted by Jets (20 hours)

Subject Matter

The momentum equation.

Newton's laws of motion, normal impact on vanes – flat or curved, vertical or inclined, stationary or moving, single or multi. Forces involved.

Smooth entrant angles (no shock) – forces on reducers and bends.

Reaction of jets. Power of jets and jet propulsion.

5.2.3.2 Reciprocating Pumps (12 hours)

Subject Matter

Introduction – definition – types – theoretical indicator diagrams.

Effect of acceleration and friction.

Use of air vessels – double acting pumps.

Application – irrigation pumping scheme.

5.2.3.3 Centrifugal Pumps (20 hours)

Subject Matter

Description and principles; manometric head, efficiencies, work done per unit weight, turning moment – speed to commence pumping – efficiency and losses – diffuser efficiency – cavitation – avoidance of cavitation – specific speed – performance of pumps and pipelines – application as above – estimation of pumping power – pump selection.

5.2.3.4 Impulse and Reaction Turbines (24 hours)

Subject Matter

Introduction and explanation of turbine types. Impulse turbines; Pelton wheel. Reaction turbines; Francis and Kaplan types.

Inward flow reaction turbines, efficiency and vane angle; vane angles head lost in runner, draft tube cavitation – avoidance of cavitation, specific speed – unit speed and unit power and pipe line. Application to power generation.

5.2.3.5 Hydraulically Operated Machinery (14 hours)

Subject Matter

Introduction and definitions.

Accumulators, intensifiers and rams.

Hydraulic cranes – mention of other machinery.

5.2.3.6 Water Hammer (8 hours)

Subject Matter

Introduction to unsteady flow in bounded systems.

Momentum theory for uniform retardation and uniform rate of reduction of gate area.

Sudden and slow closure of valves.

Effect of elasticity of pipe.

Reflection of pressure waves.

Control of surge, following valve closure with pump running, following pump shutdown.

5.2.3.7 References

1. Fluid mechanics, Massey.

2. Fluid mechanics, Douglas Gariosek et al.

3. Mechanics of fluids, A. C. Walshaw and D. A. Jonson, (Longmans).

4. Hydraulics and fluid mechanics, E. H. Lewitt, (Pitmans).

5. Fluid mechanics, R. L. Daugherty and A. C. Ingersoll, (I. S. E).

6. Fluid mechanics, V. L. Streeter (McGraw Hill).

5.2.4 Plant Installation and Maintenance (90 hours)

5.2.4.1 Installation Practice (20 hours)

Subject Matter

Importance of planning in installation.

Discussions on a variety of plant for installation, e.g. boiler, turbine, water-cooling systems, compressors, etc.

Types of foundation required for machine tools, heavy plant and buildings.

Discussions on the need for correct structural design to take loads and enable plant to be installed.

Establish case studies for building up an installation process.

Planning sequence of equipment and labor required.

The need to have good installation practices to improve the reliability of plant and equipment.

Importance of good installation practices to reduce unplanned breakdowns when plant or equipment is in operation.

Establishment at the installation stage of a machinery/plant data file, to cover installation, operating inspections and maintenance instructions, in the form of instruction sheets and specially prepared for a give piece of machinery.

5.2.4.2 Maintenance Planning (12 hours)

Subject Matter

Basics of a planned maintenance scheduling.

The necessity of planning for maintenance and the benefits, which can be gained by the company. Design planned maintenance schedules.

Types of maintenance; unplanned, corrective and planned.

Analysis of inspection reports and plant, equipment and buildings history cards for planning preventative maintenance.

5.2.4.3 Recording and Monitoring (12 hours)

Subject Matter

Preventative maintenance and standard tasks.

Planned and coordinated inspections, adjustment, repairs and replacements in the maintenance of industrial plant.

The necessity of timely repairs to prevent unscheduled interruptions or undue deterioration of operating equipment, buildings or facilities.

Routine visual inspections and study of workloads.

The carrying out of standard tasks such as lubrication, inspections, etc.

Inspection of and overall schedules for major equipment, buildings and facilities.

Checking of tolerances, wear, dimension and performance.

Building up a history of the usage of the organizations assets to plan for preventative and corrective maintenance.

5.2.4.4 Maintenance Improvement and Good Housekeeper (14 hours)

Subject Matter

Engineering analysis; the arrangement of the component parts of a job and the selection of correct materials, tools, equipment, supplies and labor to establish the best method of undertaking the job.

Break down of jobs into elemental operations to determine the possibilities for improvement relative to use, design, methods, etc. and the utilization of information to establish the standard of performance for practical use.

Understanding workshop practices; the efficient use of tools, attachments, jigs, fixtures, techniques and material for all work requirements.

Knowledge of the latest and best machines, cutting tools and equipment covering all crafts.

Emergency jobs and their classifications.

The emergency job defined as any job, which interrupts the proper planning and scheduling of work.

Good housekeeping for accident prevention. The necessity for clean aisles in workshops, machinery left in a clean condition and without protruding objects which may cause accidents.

The need for correct paints on plant, equipment and buildings.

5.2.4.5 Maintenance Cost Control (12 hours)

Subject Matter

The control of maintenance stock held items.

Establishment of maintenance costs and their interpretation relative to plant operations. Recording of maintenance expenditures for future cost comparison.

Segregation of costs into three classes; direct, indirect and general.

Explanation of costs; direct – repairs to operating or auxiliary equipment, etc.; indirect – repairs or replacement of parts, with parts of improved design, new materials or methods, etc.; general – repairs of buildings, storage tanks, roads, etc.

Establishment of responsibility for cost, reasons for costs and the need to investigate and improve.

Monthly budget charts based on the three classes, showing standard costs for maintenance against actual costs, reasons for the variances.

Instilling upon the workforce the cost effects to the company of low-grade maintenance work because of using poor methods, bad workshop practices of improper actions.

Comparison of maintenance costs relative to investment and sales values.

Establishment of monthly maintenance report covering such items as production costs, summary of planning and scheduling performance, mechanical department labor usage, breakdown of work order, e.g. labor, material, the number of work orders.

Plant inventories, plant identification and numbering, cost codes, cost summaries, inter – company cost comparisons, cost of downtime, timesheets; the use of simple computers to assist in these tasks.

5.2.4.6 Machinery and Equipment Maintenance (20 hours)

Subject Matter

Safety precautions in the maintenance of moving machinery.

Establishment of routine inspections to record data on the equipment. Visual and audio inspections on the current state of the machinery.

Carrying out and recording simple maintenance tasks – e.g. changing and checking oil, oil and air filters, sparking plugs, water levels, tire pressures, loose fittings, suspensions.

Lubrications; nipples, joints and wheel grease cups.

Checking electrical components, battery level, lighting systems, braking systems, brake fluid levels; coolant systems, etc.

The necessity of recording information on the machinery and equipment so that this information is returned to the maintenance engineers for action.

Establishing lubrication monitoring intervals, to check the lubricants for viscosity, flashpoint, foreign particles, acidity, etc. as signs of moving part wear in engines.

Maintenance particularly relevant to large heat engines; checking of pumps for seal damage. Pressure drop tests on pumps.

Liaison with local industry/users of machinery and the familiarization with the users problems and the types of failures or breakdowns which occur during the machinery's working life.

Procedures and stages relating to the overhaul of machinery – for example:

The planning stage.

The overhaul and analysis stage.

The machinery and equipment performance test trials prior to recommissioning.

Ensure that equipment is meeting suppliers' specifications during test trials.

5.2.4.7 References

Maintenance Engineering Organization and Management, Frank Gradon, Pub: Applied Science Publishers Ltd. London.

Maintenance Planning Control and Documentation, E. N. White, 2nd Edition, Pub: Gower Press.

Facilities and Plant Engineering Handbook, Edited by Bernard T. Lewis and J. P. Marron, Pub: McGraw Hill.

Maintenance Engineering Handbook, Third Edition, Higgins and Morrow, Pub: McGraw Hill.

Preventive Maintenance, Joseph D. Patton, Jr., Pub: Creative Services Inc., New York.

Maintenance Management Techniques, Antony Corder, Pub: McGraw Hill.

Standard Handbook of Plant Engineering, Robert C. Rosaler and James O. Rice, Pub: McGraw Hill.

5.3 Subjects Content of the Third Year Mechanical Engineering Production Option

5.3.1 Design and Integrative Studies (90 hours)

5.3.1.1 Design Concepts (18 hours)

Subject Matter

Standardization: effects of standardization unification on design, production and maintenance costs.

Design factors, cost, performance, safety, reliability etc.

Value analysis method with some examples.

Modelling, types of models, methods of modelling, reasons for modelling.

5.3.1.2 Jigs and Fixtures (18 hours)

Subject Matter

Principles of locating and positioning, plane locating, concentric locating, prevention of jamming, averaging method for locating rough parts.

Clamping: types of clamps, strap clamps, slide clamps, swing clamps, hinge clamps, two way or multiway clamps, cam clamps.

Clamping forces in various operations.

Safety and fool – proofing considerations.

Material selection.

5.3.1.3 Press Tools (9 hours)

Subject Matter

Selection of types of press used for a variety of jobs.

Advanced press tools; deep drawing, progressive blanking, blank layout.

Components of tools used for blanking, piercing and bending.

Design of advanced press tools.

5.3.1.4 Design for casting (9 hours)

Subject Matter

Introduction to casting processes with regard to size, section, thickness and prevention of shrinkage and cavity formation.

Design details for easy removal of the pattern from the mold.

5.3.1.5 Pneumatics (6 hours)

Subject Matter

Main components of a pneumatic system; types of compressors, motors, valves, actuators.

Advantages and disadvantages of pneumatic systems.

Some examples of application of pneumatics in production.

Clamping devices presses, feeding devices.

Methods of giving mechanical advantages.

Control of pneumatic power.

5.3.1.6 Projects (30 hours)

Subject Matter

A series of projects including the design, materials of construction, alternative ideas, engineering drawings, costing and manufacturing processes, e.g.

Blanking of rubber and leather (tools design for shoes).

Pipe bending machine.

Pneumatic guillotine.

Fly press design.

Dismounting of bearings.

2 projects of 15 hours = 30 hours

5.3.1.7 List of Projects for Second and Third year

1. Pneumatic hammer.
2. Water wheel.
3. Windmill (horizontal).
4. Construction and calibration of a venturimeters.
5. Sheet bending machine.
6. Absorption refrigerator.
7. Small steam engine.
8. Jet propelled vessel.
9. Air cooler.
10. Multi – function wood machine.
11. Electric hammer.
12. Press tools for making bolts.
13. A chair for handicapped people.
14. Wood saw.
15. Coil winding machine.
16. Development of Elsagya.
17. Grass mower.
18. Hydraulic jack.
19. Water cooler.
20. A boat propelled by pedal.
21. Windmill (vertical).

5.3.1.8 References

The below mentioned references are recommended for the following subjects:

Engineering Drawing and Design, Years 1 and 2.

Design and Integrative Studies, Year 3

1. The hydraulic trainer, Mannesmann – Rexroth.

2. Principles of Pneumatics, Trade and Technical Press.

3. Mechanical handling with precision conveyor chain, L. Jones, Hutchinson of London.

4. Principles and Methods of Sheet Metal Fabrication, G. Sachs, Reinhold.

5. Handbook of fixture design, F. W. Wilson, McGraw Hill.

6. Mechanical assembly, Boothroyd and Redford, McGraw Hill.

7. Engineering drawing and construction, L. C. Mott, Oxford University Press.

8. Fundamentals of Engineering Design, Orlov, Moscow.

9. Fluid Sealing, George Angus and Co. Ltd.

10. Material Handling, J. E. Immen, McGraw Hill.

11. Engineering design problems and their solutions, S. W. Jones, Iliffe Books.

12. Engineering drawings and design for mechanical technicians, D. E. Hewitt, MacMillan Press.

13. An introduction to assembly, W. V. Tipping, Business Books.

14. Package Conveyors Design and Estimating, D. K. Smith, Charles Griffith and Co. Ltd.

15. Machine drawing and design, W. Abbott, Blackie.

16. Engineering Design (A material processing approach), G. Dieter, McGraw Hill.

17. Manual of British Standards in Engineering Drawing and Design, B. S. I.

18. Problems in engineering design graphics, Michel/Fletcher, Prentice Hall.

19. Problems in engineering design, Elger, McGraw Hill.

20. A Manual of Engineering Drawing Practice, Simmons/Maguire, English University Press.

5.3.2 Workshop Practice (270 hours)

5.3.2.1 Advanced Workshop Techniques

A. Advanced Milling (24 hours)

Subject Matter

The use of the dividing head and form cutters to machine spur and helical gears. Method of setting cutter relative to the work. Setting dividing head to cut bevel gears. Calculation of cutter offset to obtain improved tooth form. Cam milling.

Calculation for setting dividing head for machining constant velocity cam profiles. Cutter selection and setting angles when milling saw – tooth clutches and milling cutters.

B. Advanced Grinding (24 hours)

Subject Matter

Setting of the tool and cutter grinder to resharpen end, slab and face mills.

The use of disc grinding wheels for sharpening formed milling cutters. The preparation of hardened gauges for center – type grinding, grinding cylindrical gauge tubular squares and test mandrels to fine limits

The use of the surface grinder to produce flat surfaces conventionally.

C. Lathe Work (24 hours)

Subject Matter

Use of the four-jaw chuck and different fixtures for offset and complicated turning. Grinding internal and external cylindrical components using a grinding attachment.

Lathe alignment and testing; parallel test, roundness test, lathe alignment and correction.

5.3.2.2 Small Projects (90 hours)

The student should be able to execute under close supervision a given design and make exercise.

Small projects are used as a means of teaching both advanced foundry work and advanced welding.

A. Advanced Foundry Work (24 hours)

Subject Matter

Making molds with different position of gates, risers and runners and find the best result.

Using of chills in thick sections castings.

Using sweep boards for making molds.

B. Foundry Small Project (24 hours)

Subject Matter

Study of the component, shrinkage allowance, machining allowance, position of cores, parting line.

Pattern and core box production.

Mold production and mold proving.

Critical analysis of the finished mold including the writing of a report.

C. Advanced Welding (42 hours)

Subject Matter

Positional welding oxy – acetylene and arc welding procedures and precautions to be taken, including post – heating, pre – heating and use of jibs and fixtures to minimize distortion and buildup of residual stresses.

Welding with low hydrogen arc welding electrodes.

Inspection and testing of welds, soldering and brazing, type of flux used, heating methods, and preparation of work piece.

Bronze welding, type of flux and joint preparation.

Spot welding of light sheet metal gauges.

Hard facing, preparation for hard facing, methods of depositing hard facings.

Continuous coverage, stringer leads dot pattern.

D. Welding Small Project (9 hours)

Subject Matter

To fabricate by welding, soldering brazing and/or forming a simple structure.

Select the suitable joining method, joint design and preparation, consumables, joining procedures and techniques under supervision.

Produce a satisfactory fabricated structure.

5.3.2.3 Integrated Project (72 hours)

To execute a previously designed project. The student can carry on minor design changes to overcome manufacturing difficulties without changing the aim of the project.

Gain experience by solving real manufacturing problems at the shop floor level.

Select the right and most economical manufacturing process and select the material required.

5.3.2.4 Engines Maintenance Practice (27 hours)

Hands on experience on the dismantling and assembly of engines and their major components including cylinder blocks, piston and crank removal, replacement/repair of clutches, cooling systems, ignition systems, injectors and pumps, dynamos/alternators.

5.3.3 Manufacturing Technology I (90 hours)

5.3.3.1 Machining (37 hours)

Subject Matter

A. Metal Cutting (6 hours)

Tool geometry and chip formation, machinability, tool life, factors affecting tool life, Taylor's equation, and mechanics of cutting.

B. Economics Metal Cutting (4 hours)

Variables affecting metal removal rate, economic cutting speeds, influence of other variables on the economics of cutting.

C. Precision Thread Production (3 hours)

Thread rolling using flat and circular dies.

Thread grinding by traverse and plunge cut, wheel forming.

Use of self-opening die heads.

D. Grinding (6 hours)

Cutting action of a grinding wheel, Guests theory, centerless grinding; principle of operation of external and internal process.

E. Milling (6 hours)

Spiral, cam and clutch milling.

Bevel gear milling.

F. Process Capability (6 hours)

Statistical analysis of machine tool capability.

Parameters affecting process capability.

Cost of accuracy. Comparison of relative costs of various machining processes.

G. Machine Tools (6 hours)

Classification and selection of machine tools.

Structural elements, deflection and vibration (chatter) of machine tool elements.

Machine tool mounting, installation and alignment.

5.3.3.2 Metrology (25 hours)

Subject Matter

A. Gauging (6 hours)

Taylor's principle of gauging, gauge design and tolerancing, checking tapered holes.

Application of Taylor's principle to the design of screw threads gauges. Disposition of tolerances on screw threads with reference to appropriate standard.

Select screw thread gauges for particular applications.

B. Optical Projector (5 hours)

Optical system of profile projector, schematic of profile projector, principle of operation.

Application to screw thread measurement.

Templates, projector lenses.

C. Surface Finish (3 hours)

Significance of graphical results of surface finish; interpretation of graphical records.

Importance of correct magnification.

Definition of primary and secondary texture.

Lay and its importance to taking surface readings.

Surface finish and relationship with wear.

D. Roundness (3 hours)

Use of polar traces to determine roundness.

Equipment used for roundness testing.

Interpretation of errors shown on polar traces.

Minimum zone concept, least squares center.

E. Toolmaker's Microscope (3 hours)

Operating principle, areas of application.

F. Gear Measurement (5 hours)

Terms related to gear measurement, measurement of chordal thickness, constant chord, base pitch, and base tangent. Pitch wide diameter and errors in tooth profile.

Identify gear errors and relate them to manufacturing methods and performance.

5.3.3.3 Advanced Machining (28 hours)

Subject Matter

A. Production Equipment (10 hours)

Further applications of jigs and fixtures in advanced machining practice.

Application of drill jigs. Application of milling, turning, grinding, boring and welding fixtures.

Modern tooling concepts; ISO indexible tooling system tooling system, block tooling.

B. Quantity Production (9 hours)

Principles of capstan and automatic lathes.

Process planning for capstan lathes.

Break-even analysis as a means of establishing the most economic method of manufacture.

C. Gear Manufacture (9 hours)

Planing, shaping and hobbing of the involute gear form.

Single and double helical gears.

Generation of splines, serrations and other profiles.

Gear finishing methods; shaving, grinding, rolling.

5.3.3.4 References

Principles of Engineering Production, Lissaman, A. J. and Martin, S. J. (Hodder and Stoughton).

Manufacturing technology, Haslehurst, M. (Hodder and Stoughton).

5.3.4 Manufacturing Technology II (90 hours)

5.3.4.1 Automation of Manufacture and Mechanized Assembly (15 hours)

Subject Matter

A. Automated Assembly (4 hours)

The need for auto – assembly, the cost and quality, the limitations of auto – assembly system, design limitations, capital cost.

B. Equipment (3 hours)

Mechanized assembly machine, feeding devices, control of movement, indexing machine to move the work from station to station, fixture for holding the work.

Convey to remove the work.

C. Layout and Planning (3 hours)

Calculation of downtime between stations.

Station layout – in line indexing, rotary indexing.

5.3.4.2 Metal forming (15 hours)

Subject Matter

A. Metal Working Theory (3 hours)

Yielding, Mohr's circle and yield criteria, simple estimation of working load from yield stress, slip plane.

B. Stress/Strain (8 hours)

Tensile test, true stress and natural strain, simplified form of stress – strain curve, selection of stress – strain curves for hot and cold working. Yield criteria, Tresca maximum shear stress criterion, and Von Mises maximum shear strain energy criterion, relation between tensile yield stress and shear yield stress, yield under plane – strain condition. Mohr's circle – application to three-dimensional stress.

C. Working Loads and Work Analysis (4 hours)

To be applied to do the following:

1. Drawing of round and flat strips: Assessment of drawing force, determination of plane – strain drawing.
2. Extrusion: assessment of forces and strains when extruding round pars and flat strips.

3. Rolling: assessment of roll force and stresses (for flat slabs and strips)

5.3.4.3 Plastics (20 hours)

Subject Matter

A. Behavior of Plastics (5 hours)

Visco – elastic behavior of plastics, creep and stress relaxation, rheology, viscosity. Newtonian and non – Newtonian behavior, effect of temperature.

B. Injection Mold Design (11 hours)

Design methods for plastics using deformation data and isochronous and isometric curves.

Mold layout for balance locking force, economic number of cavities.

Runner and gate design.

Use of inserts.

C. Plastic Processing (4 hours)

Mechanization of plastic molding and forming processes.

The management of mechanized systems.

5.3.4.4 Application of Computers in manufacturing (15 hours)

Subject Matter

A. Fundamentals of NC (5 hours)

The numerical control system, numerical control data – part program. Machine control unit, command lines, drive and feedback device. Advantages of NC systems.

B. Classification of NC Systems (8 hours)

Point to point, straight line and contouring.

Incremental and absolute systems.

Open and closed loop control.

The punched tape, ISO codes.

Application of NC to milling, turning and welding.

C. Computers in NC (2hours)

CNC and ONC, typical industrial applications.

5.3.4.5 References

Metrology for engineers, Galyer and Shotbolt, Pub: Cassel.

Production Engineering Technology, J. D. Radford and D. B. Richardson.

5.3.5 Production Planning and Control (90 hours)

5.3.5.1 Organization (10 hours)

Subject Matter

The relationship of the manufacturing department to the following parts of the organization: marketing, design, quality, assurance, finance, personnel, purchasing.

Typical responsibilities of the chief production executive with respect to production, work-study, planning and control, and maintenance.

Types of production (jobbing, batch, flow) and the effects of a manufacturing information system. Principles of management by objectives and management by exception. The information flow between major departments in a manufacturing organization.

5.3.5.2 Scheduling (15 hours)

Subject Matter

Procedures for converting orders into production schedules.

Effect of scheduling on plant loading.

The need for rescheduling for split batches.

Justification of the use of expediting.

Preparation of progressing schedules.

Preparation of a jobbing shop schedule.

5.3.5.3 Scheduling (15 hours)

Subject Matter

Identification of types of stores and their uses.

The principles of palletized storage and discuss their application. Description of methods of handling pallets in the store and in the plant. Identification methods of stock recording.

The need for accurate stock recording. Causes of stock record errors. Ways in which stock errors may be minimized.

5.3.5.4 Quality Assurance (30 hours)

Subject Matter

Definition of appraisal, prevention and failure costs.

The relationship between quality cost elements using graphical techniques. Definition of optimum quality level concepts which minimize costs. Distinguishing between attribute and variable data. Description of control charts as a method for monitoring and process capability.

Comparisons of various charting methods; show chart, single, double, multiple. Plot, mean and range charts.

The use of operating characteristic curves of sampling schemes. Discussion of the choice of suitable sampling schemes. The application of confidence limits in relation to sampling problems. The role of inspection – patrol, central, decentral. Outline inspection practice.

5.3.5.5 References

Production Management, R. Wild. (Holt U.K.).

Production Control, K. Lockyer (Pitman).

Quality Assurance, British Standards 5570.

Chapter Six

Concluding Remarks of the Study

A final suggestion pertains more generally to how we frame studying and working in engineering, science, and technology fields within a broader social context. Aligning these fields with the services they render to society as a whole will do much to attract the best students for the best reasons.

In summary, the plan that was set by Vocational Training and Apprenticeship (SCVTA) and Vocational Training Centers (VTCs) and other participants revealed several important issues related to technical education in Sudan. The participants acknowledged the mixed historical experiences and stigma associated with technical education. Yet while they were aware of the difficult challenges and obstacles facing Sudan, including political ambiguity over the upcoming democratic elections and capacity challenges, many of the participants in this study were also optimistic and hopeful for positive change. There are considerable opportunities for developing a diverse array of marketable and apprenticeable trades specific to Sudan which can contribute to sustainable development and post democratic transformation reconstruction. There is no doubt that technical education is crucial if local people are to participate in nation-building and benefit from expanding market activity in Sudan.

The present study has been considered from the point of view of introduction, course philosophy and objectives, syllabuses of the first year of the diploma course, syllabuses of the second year of the diploma course, and syllabuses of the third year of the diploma course and finally the concluding remarks of the study.

The main objective of the present 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 [32].

The aims of the course relate specifically to the skills to be acquired through the education provided. At the conclusion of the course, the graduate technician should be able to: Design simple components, particularly as this applies to plant maintenance, repair, and development; Maintain plant and machinery to a high standard; Exhibit skills required in basic engineering manufacturing processes; Organize work in manufacturing industry, maintenance and repair workshops or power plants; Train skilled laborers to a higher standard.

In this context, the Atbara graduate might be expected to take up supervisory jobs in manufacturing and repair industry or operational work in power industries: e.g. supervisor (i.e. foreman), planning engineer, fault analyst, shift charge engineer, training supervisor/manager.

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Author Autobiography

Osama Mohammed Elmardi Suleiman Khayal was born in Atbara, Sudan in 1966. He received his diploma degree in mechanical engineering from Mechanical Engineering College, Atbara, Sudan in 1990. He also received a bachelor degree in mechanical engineering from Sudan University of science and technology – Faculty of engineering in 1998, and a master degree in solid mechanics from Nile valley university (Atbara, Sudan) in 2003, and a PhD in structural engineering in 2017. He contributed in teaching some subjects in other universities such as Red Sea University (Port Sudan, Sudan), Kordofan University (Obayed, Sudan), Sudan University of Science and Technology (Khartoum, Sudan), Blue Nile University (Damazin, Sudan) and Kassala University (Kassala, Sudan). In addition, he supervised more than three hundred and fifty under graduate studies in diploma and B.Sc. levels and about fifteen master theses. The author wrote about hundred engineering books written in Arabic language, and hundred books written in English language and more than hundred and fifty research papers in fluid mechanics, thermodynamics, internal combustion engines and analysis of composite structures. He authored more than three hundred of lectures notes in the fields of mechanical, production and civil engineering He is currently an associate professor in Department of Mechanical Engineering, Faculty of Engineering and Technology, Nile Valley University Atbara, Sudan and now he is the faculty dean. His research interest and favorite subjects include structural mechanics, applied mechanics, control engineering and instrumentation, computer aided design, design of mechanical elements, fluid mechanics and dynamics, heat and mass transfer and hydraulic machinery. The author also works as a technical manager and superintendent of Al – Kamali mechanical and production workshops group which specializes in small, medium and large automotive overhaul maintenance and which situated in Atbara city in the north part of Sudan, River Nile State.