Republic of the Philippines
OFFICE OF THE PRESIDENT
COMMISSION ON HIGHER EDUCATION

CHED MEMORANDUM ORDER (CMO)
No. 09
Series of 2008

SUBJECT : **POLICIES AND STANDARDS (PS) FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING (BSME)**

In accordance with the pertinent provisions of Republic Act (RA) No. 7722, otherwise known as the "Higher Education Act of 1994," upon the recommendation of the Technical Panel for Engineering, Technology and Architecture and by virtue of Resolution No. 740-2007 of the Commission en banc dated October 15, 2007, for the purpose of rationalizing the undergraduate program in Bachelor of Science in Mechanical Engineering with the end view of keeping apace with the demands of global competitiveness, the following policies and standards are hereby adopted and promulgated by the Commission, thus:

ARTICLE I -INTRODUCTION

Section 1. Rationale and Background.

Mechanical Engineering is one of the oldest and broadest branches of engineering. The American Society of Mechanical Engineers (ASME) defines it as follows:

> Mechanical Engineering is a profession that concerns itself with mechanical design, energy conversion fuel and combustion technologies, heat transfer, materials, noise control and acoustics, manufacturing processes, rail transportation, automatic control, product safety and reliability, solar energy, and technological impacts to society. Mechanical engineers study the behavior of materials when forces are applied to them, such as the motion of solids, liquids, gases, and heating and cooling of object and machines. Using these basic building blocks, engineers design space vehicles, computers, power plants, intelligence machines and robots, automobiles, trains, airplanes, furnaces, and air conditioners. Mechanical engineers work on jet engine design, submarines, hot air balloons, textiles and new materials, medical and hospital equipment, and refrigerators and other home appliances. Anything that is mechanical or must interact with another machine or human being is within the broad scope of today's and tomorrow's mechanical engineer.

The above ASME definition of mechanical engineering is a comprehensive one, however, only some of its element may be covered in the undergraduate level. The Task Force in Mechanical Engineering, therefore, designs a broad-based mechanical engineering curriculum that emphasizes the fundamental knowledge and skills of mechanical engineering and introduces new emerging areas in the

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discipline. To meet this purpose, the curricular requirements for elective courses are increased to twelve units. These elective courses may be utilized to introduce new courses in mechanical engineering as suggested by these curricular guidelines or to design a concentration or tracking in the mechanical engineering program such as manufacturing engineering, mechatronics engineering, automotive engineering, biomedical engineering, HVAC/R engineering (heating, ventilating, air – conditioning and refrigerating), etc. The Task Force strongly suggests that in the selection of new elective courses or in the design of a concentration or tracking, the school considers the thrust of industrial development in their locality or region. Furthermore, the new mechanical engineering curriculum includes a senior design or thesis project that addresses the specific needs of the communities where the schools are located.

The herein Policies and Standards (PS) have been reviewed in accordance with recently approved CMOs, industry needs, latest trends and technology in the field of mechanical engineering. This PS emerged as a result of consolidated efforts of the academe, industry and other concerned agencies.

ARTICLE II - AUTHORITY TO OPERATE

Section 2. All private higher education institutions (PHEIs) intending to offer **Bachelor Of Science in Mechanical Engineering** must first secure proper authority from the Commission in accordance with existing rules and regulations. State Universities and Colleges (SUCs), and Local Colleges and Universities (LCUs) should likewise strictly adhere to the provisions of these policies and standards.

ARTICLE III -PROGRAM SPECIFICATION

Section 3. Degree Name

The degree program herein shall be called **BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING (BSME).**

Section 4. Program Description

4.1 Objectives

To provide quality Mechanical Engineering education for global competitiveness

4.2 Program Outcomes

A graduate of the Bachelor of Science in Mechanical Engineering (BSME) program must have attained:

a. An ability to apply knowledge of mathematics, science and engineering

ARTICLE IV - COMPETENCY STANDARDS

Section 6. This section defines the entry-level competency standards, knowledge, attitudes, values and skills applicable to the BS Mechanical Engineering graduate, which are contained in **ANNEX I** of this Memorandum.

ARTICLE V - CURRICULUM

Section 7. Curriculum Description

7.1 The BS Mechanical Engineering curriculum has a total of 211 credit units. The program comprised of the general education, technical, allied, fundamental, professional, technical elective courses and plant visit or on-the-job-training.

7.2 The general education courses are in accordance with the requirements of the CHED Memorandum Order No. 59, s. 1996- The New General Education Curriculum B (GEC -B)

7.3 The technical courses comprised of the 26 units of Mathematics, 12 units of Physical/Natural Sciences, 21 units of Basic Engineering Sciences, 10 units of allied courses, 54 units of fundamental courses, 23 units of professional courses and 12 units of technical elective courses.

7.4 The non-technical courses comprised of 39 units of languages, humanities, social sciences and 14 units of PE/NSTP.

Section 8. Curriculum Outline

Classification/ Field / Course	Minimum Hours/week		Minimum Credit Units
	Lecture	Laboratory	
I. TECHNICAL COURSES			
A. Mathematics			
College Algebra	3	0	3
Advanced Algebra	2	0	2
Plane and Spherical Trigonometry	3	0	3
Analytic Geometry	2	0	2
Solid Mensuration	2	0	2
Differential Calculus	4	0	4
Integral Calculus	4	0	4
Differential Equations	3	0	3
Probability and Statistics	3	0	3
Sub-Total	**26**	**0**	**26**

Classification/ Field / Course	Minimum Hours/week		Minimum Credit Units
	Lecture	Laboratory	
B. Natural/Physical Sciences			
General Chemistry	3	3	4
Physics 1	3	3	4
Physics 2	3	3	4
Sub-Total:	**9**	**9**	**12**
C. Basic Engineering Sciences			
Engineering Drawing	0	3	1
Computer Fundamentals and Programming	0	6	2
Computer –Aided Drafting	0	3	1
Statics of Rigid Bodies	3	0	3
Dynamics of Rigid Bodies	2	0	2
Mechanics of Deformable Bodies	3	0	3
Engineering Economy	3	0	3
Engineering Management	3	0	3
Environmental Engineering	2	0	2
Safety Management	1	0	1
Sub-Total:	**17**	**12**	**21**
D. Allied Courses			
Basic Electrical Engineering	2	3	3
Basic Electronics	2	3	3
DC and AC Machinery	3	3	4
Sub-Total:	**7**	**9**	**10**
E. Fundamental Mechanical Engineering Courses			
Orientation to ME	1	0	1
Advanced Engineering Mathematics for ME	3	0	3

Classification/ Field / Course	Minimum Hours/week		Minimum Credit Units
	Lecture	Laboratory	
Methods of Research for ME	1	0	1
Fluid Mechanics	3	0	3
Machine Elements 1	2	3	3
Machine Elements 2	2	3	3
Materials Engineering	3	3	4
Thermodynamics 1	3	0	3
Thermodynamics 2	3	0	3
Combustion Engineering	2	0	2
Heat Transfer	2	0	2
ME Laboratory 1	0	6	2
ME Laboratory 2	0	6	2
Industrial Processes	2	0	2
Safety Engineering for ME	2	0	2
Workshop Theory and Practice	0	6	2
Machine shop Theory	0	6	2
Instrumentation and Control Engineering	2	3	3
Fluid Machinery	3	0	3
Refrigeration Systems	3	0	3
Airconditioning and Ventilation Systems	2	3	3
Vibration Engineering	2	0	2
Sub-Total:	**41**	**39**	**54**
F. Professional Mechanical Engineering Courses			
Machine Design 1	3	0	3
Machine Design 2	3	0	3
ME Laboratory 3	0	6	2
Industrial Plant Engineering	3	0	3
Power Plant Engineering	4	3	5

Classification/ Field / Course	Minimum Hours/week		Minimum Credit Units
	Lecture	Laboratory	
ME Laws, Ethics, Codes and Standards	3	0	3
Plant Visit/OJT	0	6	2
ME Project Study 1	0	3	1
ME Project Study 2	0	3	1
Sub-Total:	**16**	**21**	**23**
G. Electives Courses			
ME Electives	12	0	12
Sub-Total:	**12**	**0**	**12**
II. NON-TECHNICAL COURSES			
A. Social Sciences			
Social Science 1	3	0	3
Social Science 2	3	0	3
Social Science 3	3	0	3
Social Science 4	3	0	3
Sub-Total:	**12**	**0**	**12**
B. Humanities			
Humanities 1	3	0	3
Humanities 2	3	0	3
Humanities 3	3	0	3
Sub-Total:	**9**	**0**	**9**
C. Languages			
English 1	3	0	3
English 2	3	0	3
English 3 (Technical Communication)	3	0	3
Pilipino 1	3	0	3
Pilipino 2	3	0	3
Sub-Total:	**15**	**0**	**15**

Classification/ Field / Course	Minimum Hours/week		Minimum Credit Units
	Lecture	Laboratory	
D. Mandated Course			
Life and Works of Rizal	3	0	3
Sub-Total:	**3**	**0**	**3**
E. Physical Education			
P.E. 1, 2,3,4 (2 units each)			8
Sub-Total:			**8**
F. National Training Service Program			
NSTP 1			3
NSTP 2			3
Sub-Total:			**6**
GRAND TOTAL	**167**	**90**	**211**

Suggested Elective Courses:

A. Mechatronics Engineering

1. Mechatronics
2. Introduction to Robotics
3. Industrial Robot
4. Control Systems Engineering
5. Digital Control
6. Industrial Automation & Control

B. Automotive Engineering

1. Automotive Engineering
2. Automotive Control
3. Crankshaft and Dampers Design
4. Fundamental of Engine Block Design.
5. Power Train Noise Vibration and Harshness
6. Inherent Engine Unbalance
7. Safety of Motor Vehicles
8. Engine Crankcase Ventilation
9. Engine Emissions and Control
10. Engine Fuel Control Systems
11. Catalytic Converters
12. Intake Manifold and Induction System Design
13. Engine Friction and Lubrication
14. Combustion Technology
15. Tribology
16. Aerodynamics

C. Energy Engineering and Management

1. Alternative Energy Resource
2. Nuclear Energy
3. Solar Energy and Wind Energy Utilization
4. Energy Management in Buildings
5. Energy Management Industry
6. Micro-hydro-electric Power Plant Design
7. Management of Technology

D. Computers and Computational Science

1. Computer Aided Design and Manufacturing
2. Finite Element Method
3. Computational Fluid Mechanics

E. Manufacturing Engineering

1. Tool and Die Design.
2. Jigs and Fixture Design
3. Manufacturing Processes and System
4. Materials Failure in Mechanical Applications
5. Introduction to Precision Engineering
6. Materials Characterization

F. Heating, Ventilating, Air-Conditioning and Refrigeration

1. Conduction Heat Transfer
2. Convection Heat Transfer
3. Radiation Heat Transfer.
4. Advanced Refrigeration and Air-Conditioning
5. Design of Thermal System
6. Indoor Air Quality in Buildings
7. Ventilation and Air-Conditioning
8. Design of Building Piping Systems
9. Noise and Vibration in Mechanical Services

G. Biomechanics

1. Biomechanics of Human Movement and Control
2. Orthopedics and Injury Mechanics

SUMMARY OF THE BSME CURRICULUM

Classification/ Field	Total No. of Hours		Total No. of Units
	Lecture	Laboratory	
I. TECHNICAL COURSES			
A. Mathematics	26	0	26
B. Natural/Physical Sciences	9	9	12
C. Basic Engineering Sciences	17	12	21
D. Allied Courses	7	9	10
E. Fundamental Courses	41	39	54
E. Professional Courses	16	21	23
F. Technical Electives	12	0	12
TOTAL (TECHNICAL)	**128**	**90**	**158**
II. NON-TECHNICAL COURSES			
A. Social Sciences	12	0	12

Classification/ Field	Total No. of Hours		Total No. of Units
	Lecture	Laboratory	
B. Humanities	9	0	9
C. Languages	15	0	15
D. Mandated course	3	0	3
E. Physical Education			8
F. National Training Service Program			6
TOTAL (NON-TECHNICAL)	**39**	**0**	**53**
GRAND TOTAL	**167**	**90**	**211**

Section 9. Relationship of the Courses to the Program Outcomes

The relationships of the identified courses in section 8 to the identified program outcomes in section 4-4.2 are contained in **ANNEX II** of this Memorandum.

Section 10. Sample/ Model program of study

The institution may enrich the sample/model program of study depending on the needs of the industry, provided that all prescribed courses required in the curriculum outlines are offered and pre-requisites are complied with.

FIRST YEAR

1st Year – First Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
College Algebra	3	0	3	None
Plane and Spherical Trigonometry	3	0	3	None
General Chemistry	3	3	4	None
Engineering Drawing	0	3	1	None
Orientation to ME	1	0	1	None
English 1	3	0	3	None
Pilipino 1	3	0	3	None
PE 1			2	
NSTP 1			3	
TOTAL	**16**	**6**	**23**	

b. An ability to design and conduct experiments, as well as to analyze and interpret data
c. An ability to design a system, component or process to meet desired needs within realistic constraints
d. An ability to function on multi-disciplinary teams
e. An ability to identify, formulate and solve engineering problems
f. An understanding of professional and ethical responsibility
g. An ability to communicate effectively in both Filipino and English languages
h. An understanding of the impact of engineering solutions in a global and societal context
i. An ability to use techniques, skills and modern engineering tools necessary for mechanical engineering practice

4.3 Specific Professions/ Careers/ Occupations or trades that the graduates may go into

4.3.1 Fields of Specialization

1. Power and Energy Engineering
2. Automotive Engineering
3. Manufacturing Engineering
4. Mechatronics and Robotics
5. Heating, Ventilating, Air-conditioning and Refrigeration (HVAC & R)
6. Biomedical Engineering
7. Instrumentation and Controls

4.3.2 Career Options

1. Operations
2. Maintenance
3. Design and Consultancy
4. Production
5. Education
3. Entrepreneurship
4. Management and Supervision
8. Sales and Marketing
9. Research and Development

Section 5. Allied Programs :

For purposes of determining the faculty qualifications, the following are the BSME allied programs:

1. Electrical Engineering
2. Manufacturing Engineering
3. Aeronautical/Aerospace Engineering
4. Environmental Engineering
5. Biomedical Engineering
6. Mechatronics and Robotics Engineering

1st Year – Second Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Advanced Algebra	2	0	2	College Algebra
Analytic Geometry	2	0	2	College Algebra, Plane and Spherical Trigonometry
Solid Mensuration	2	0	2	College Algebra, Plane and Spherical Trigonometry
Physics 1	3	3	4	College Algebra, Plane and Spherical Trigonometry
English 2	3	0	3	
Pilipino 2	3	0	3	
Humanities 1	3	0	3	
PE 2			2	
NTSP 2			3	
TOTAL	**18**	**3**	**24**	

SECOND YEAR

2nd Year – First Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Differential Calculus	4	0	4	Analytic Geometry, Solid Mensuration, Advanced Algebra
Physics 2	3	3	4	Physics 1
English 3 (Technical Communication)	3	0	3	English 2
Computer Fundamentals and Programming	0	6	2	2nd Year Standing
Humanities 2	3	0	3	
Social Science 1	3	0	3	
PE 3			2	
TOTAL	**16**	**9**	**21**	

2nd Year – Second Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Integral Calculus	4	0	4	Differential Calculus
Basic Electrical Engineering	2	3	3	Physics 2
Probability & Statistics	3	0	3	College Algebra
Humanities 3	3	0	3	
Social Science 2	3	0	3	
Life and Works of Rizal	3	0	3	
PE 4			2	
TOTAL	**18**	**3**	**21**	

THIRD YEAR

3rd Year – First Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Differential Equations	3	0	3	Integral Calculus
Statics of Rigid Bodies	3	0	3	Physics 1, Integral Calculus
Workshop Theory and Practice	0	6	2	Engineering Drawing
Computer – Aided Drafting	0	3	1	3rd year standing
Machine Elements 1	2	3	3	Dynamics of Rigid Bodies
Thermodynamics 1	3	0	3	Integral Calculus, Physics 2
Environmental Engineering	2	0	2	General Chemistry
Social Science 3	3	0	3	
TOTAL	**16**	**12**	**20**	

3rd Year – Second Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Dynamics of Rigid Bodies	2	0	2	Statics of Rigid Bodies
Mechanics of Deformable Bodies	3	0	3	Statics of Rigid Bodies
Machine Elements 2	2	3	3	Machine Elements 1
Machine Shop Theory	0	6	2	Workshop Theory and Practice
Basic Electronics	2	3	3	Basic Electrical Engineering
Thermodynamics 2	3	0	3	Thermodynamics 1
Fluid Mechanics	3	0	3	*Prerequisite:* Thermodynamics 1, *Corequisite:* Dynamics of Rigid Bodies
Safety Management	1	0	1	Third year standing
Social Science 4	3	0	3	
TOTAL	**19**	**12**	**23**	

FOURTH YEAR

4th Year – First Semester

Description of Subjects	No. of hours		Units	Prerequisites/*Corequisite*
	Lecture	Laboratory		
ME Laboratory 1	0	6	2	Fluid Mechanics
Machine Design 1	3	0	3	*Prerequisites*: Machine Elements 2, Mechanics of Deformable Bodies *Corequisite:* Materials Engineering
Heat Transfer	2	0	2	Thermodynamics 1, Differential Equations, Fluid Mechanics
Materials Engineering	3	3	4	General Chemistry, Mechanics of Deformable Bodies
DC and AC Machinery	3	3	4	Basic Electrical Engineering
Advanced Engineering Mathematics for ME	3	0	3	Differential Equations
ME Elective 1	3	0	3	
TOTAL	**17**	**12**	**21**	

4th Year – Second Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
ME Laboratory 2	0	6	2	ME Laboratory 1, Heat Transfer
Fluid Machinery	3	0	3	Fluid Mechanics
Combustion Engineering	2	0	2	Thermodynamics 2, Heat Transfer
Engineering Economy	3	0	3	Third year standing
Refrigeration Systems	3	0	3	Thermodynamics 2, Heat Transfer
Machine Design 2	3	0	3	Machine Design 1
Methods of Research for ME	1	0	1	English 3 (Technical Communication), Probability and Statistics
ME Elective 2	3	0	3	
TOTAL	**18**	**6**	**20**	

FIFTH YEAR

5th Year – First Semester

Description of Subjects	No. of hours		Units	Prerequisites/*Corequisites*
	Lecture	Laboratory		
Plant Visit/OJT	0	6	2	*Prerequisite*: Orientation to ME *Corequisite* : Industrial Processes, Safety Engineering for ME
Air conditioning and Ventilation Systems	2	3	3	Refrigeration Systems
ME Laboratory 3	0	6	2	ME Laboratory 2
Instrumentation and Control Engineering	2	3	3	Basic Electronics Engineering
Industrial Processes	2	0	2	*Prerequisite*: ME Laboratory 2 *Corequisite* :Safety Engineering for ME
Vibration Engineering	2	0	2	Differential Equation, Dynamics of Rigid Bodies
Safety Engineering for ME	2	0	2	*Prerequisite*: 4th year standing, *Corequisite* : Industrial Processes, Plant Visit/OJT
ME Project Study 1	0	3	1	Machine Elements 2, Refrigeration Systems, Fluid Mechanics, Engineering Economics, Methods of Research for ME
ME Elective 3	3	0	3	
TOTAL	**13**	**21**	**20**	

5th Year – Second Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Industrial Plant Engineering	3	0	3	Industrial Processes, Plant visit/OJT
ME Laws, Ethics, Codes and Standards	3	0	3	Senior Status, Orientation to ME
Power Plant Engineering	4	3	5	Combustion Engineering, Fluid Machinery, Heat Transfer
ME Project Study 2	0	3	1	ME Project Study 1.No Course specifications
Engineering Management	3	0	3	Third Year Standing
ME Elective 4	3	0	3	
TOTAL	**16**	**6**	**18**	

Total = 211 units

Section 11. Thesis/Research/project study requirement

11.1 The Thesis /research/project requirement shall focus on :
- 11.1.1 Alternative Sources of Energy/Renewable Energy
- 11.1.2 Mechatronics / Robotics/Nanotechnology
- 11.1.3 Manufacturing Technologies
- 11.1.4 Thermofluid Science
- 11.1.5 Biomedical Engineering
- 11.1.6 Environmental Technologies

Section 12. On-the-job-training or practicum requirement

The mechanical engineering practice (OJT) is comprised of 120 hours and is required to be taken preferably during the summer prior to his terminal year.

12.1 During the final year of a mechanical engineering student, he/she is required to take up the OJT/ Plant visits, as a requirement before he/she graduates

12.2 The students may have his/her OJT in any of the following industries:
- 12.2.1 Power Plants
- 12.2.2 Industrial Plants
- 12.2.3 Manufacturing Companies
- 12.2.4 Service Companies / Industrial Sales
- 12.2.5 Machine Shops and Foundries
- 12.2.6 Engineering Contracting Companies
- 12.2.7 Mechanical Engineering / Management Consultancy Firms

12.3 Plant visits may be allowed as a substitute to the OJT as long as there is substantial equivalence of the activities.

ARTICLE VI - COURSE SPECIFICATION

Section 13. The course specifications for the BS Mechanical Engineering program are contained in **ANNEX III** of this Memorandum; **ANNEX IV** shall contain the summary of the Laboratory requirements.

1. Course Name
2. Course Description
3. Number of units for lecture and laboratory
4. Number of contact hours per week
5. Prerequisite
6. Course Objectives
7. Course Outlines
8. Equipment
9. References

ARTICLE VII - GENERAL REQUIREMENTS

Section 14. The general requirements for the BS Mechanical Engineering Program are contained in **"CMO 25, S. 2005 – Revised Policies, Standards and Guidelines (PSG) for Engineering Education"**, a separate Memorandum issued by the Commission.

The following are hereby required to comply with the policies in the following areas:

1. Instructional Program Quality
2. Research
3. Community Involvement
4. Administration and Support

ARTICLE VIII - TRANSITORY PROVISION

Section 15. HEIs that have been granted permit or recognition for Bachelor of Science in Mechanical Engineering degree program are required to fully comply with all the requirements in this CMO, within a non-extendable period of three (4) years after the date of its effectivity. State Universities and Colleges (SUCs) and Local Colleges and Universities (LCUs) shall also comply with the requirements herein set forth.

A student currently enrolled in the Bachelor of Science in Mechanical Engineering program shall be allowed to graduate under the old curriculum. However, students enrolling for the above-mentioned program beginning school year 2008-2009 shall be covered by this CMO.

ARTICLE IX- SANCTIONS

Section 16. For violation of this Order, the Commission may impose such administrative sanction as it may deem appropriate pursuant to the pertinent provisions of Republic Act No. 7722, in relation to Section 69 of BP 232 otherwise known as the Higher Education Act of 1982, and Sections 24 and 101 of the Manual of Regulations for Private Schools (MRPS), and other related laws.

ARTICLE X – SEPARABILITY AND REPEALING CLAUSE

Section 17. Any provision of this Order, which may thereafter be held invalid, shall not effect the remaining provisions.

Section 18. All issuances, including but not limited to CMO No. 49, s. 1997, and CMO 34, s. 2001 and/ or any part thereof inconsistent herewith, are deemed repealed or modified accordingly.

ARTICLE XI - EFFECTIVITY CLAUSE

Section 19. This CMO shall take effect starting 1st semester of SY 2008-2009, after publication in an official gazette or in a newspaper of general circulation.

Section 20. An educational institution applying to offer new BSME program shall likewise comply with all the provisions of this CMO. (see Article II – Authority to Operate of this Memorandum)

Pasig City, Philippines April 10, 2008

For the Commission:

ROMULO L. NERI
Acting Chairman

ANNEX I

COMPETENCY STANDARDS

PROFILE OF DUTIES AND COMPETENCIES OF A MECHANICAL ENGINEER-ENTRY LEVEL

GENERAL DUTIES	SUB-DUTIES	COMPETENCIES					
		1	2	3	4	5	6
1. Research and Development	**1.1Apply knowledge of mathematics and engineering principles**	Understand the principles of mathematics, natural, physical and applied sciences	Determine appropriate engineering principles and technique application to the concept design	Develop the ability to use techniques, skills and medium tools such as computer software necessary for engineering practice			
	1.2Conceptualize, Design, and Implement machines products, processes for the benefit of consumers	Understand engineering concepts & inventions applied in the course	Should know Design subjects, product development, kinematics, strength of materials and engineering mechanics	Interpret engineering plans	Acquire an in-depth understanding of the principles and needs of engineering design		

GENERAL DUTIES	SUB-DUTIES	COMPETENCIES					
		1	2	3	4	5	6
1. Research and Developme	**1.3. Conform with technical specification and standards**	Familiarize with engineering standards	Undertake engineering design according to international practices				
	1.4 Conduct scientific research	Understand the research process and apply the principles of mathematics, physical, natural and applied sciences	Collect, evaluate, assess, transform data into meaningful and useful information	Design and conduct experiments, analyze and interpret data, document and disseminate	Analyze and validate data and write technical reports	Function on multi-disciplinary teams	
	2.1 Understand contemporary issues & technological trend and IPPR	Understand technology life cycle	Acquire information on the product from different sources on the same industry	Observe rules on intellectual property rights	Diagnose product system failure or deficiency characteristic		

GENERAL DUTIES	SUB-DUTIES	COMPETENCIES					
		1	2	3	4	5	6
2. Technology Innovation	**2.2 Create prototypes**	Understand the principles of technological innovation	Adopt engineering inter-disciplinary requirements and prototypes	Identify technical system contradiction and resolve them	Interpret product design(improvement, changes,….)		
	2.3 Apply technology transfer and facilitate innovation	Know appropriate technologies	Understand process of technological transfer	Establish feedback mechanism	Demonstrate technology leadership	Seek interface between industry and academe	
	2.4 Identifies and implements best practices	Know industry practices	Know ethical & legal standards & practices product innovation	Conduct bench markings	Apply learning's and skills to ME practice		
	3.1 Evaluate technical systems issues	Understand the work process and purpose	Develop and assess periodic test performance and monitoring of system	Document evaluated issues	Understand the impact of engineering solutions in a global and societal context		

GENERAL DUTIES	SUB-DUTIES	COMPETENCIES					
		1	2	3	4	5	6
3. Management	**3.2 Analyze and design mechanical engineering systems**	Review ME systems operations	Define ME system performance & parameters	Develop ME systems design	Document data design		
	3.3. Analyze technical problem thru mechanical systems integration	Comprehend different subsystems	Recognize inter-relating subsystems	Harmonize subsystems	Ensure integrated systems developed is operational		
	3.4 Communicate effectively and efficiently	Demonstrate verbal, written and other form of communication	Communicate proficiently the technical report writing and documentation	Demonstrate the at of public speaking as presentor, facilitator, mentor and trainer	Create strategies for information dissemination		
	3.5 Understand Engineering Business /Organization	Understand the basic concepts, tools and areas of applications of business management, with particular emphasis on operation and project management.	Supervise and monitor the performance of project milestone and operational targets.				

GENERAL DUTIES	SUB-DUTIES	COMPETENCIES					
		1	2	3	4	5	6
3. Management	**3.6 Understand ethical practices**	Recognize the principles of ethics	Be able to practice high moral standards in all undertakings	Promote social responsibility.	Develop concern for the environment		
	3.7 Understanding human behaviour and develop strategies, Supervises a team	Understand organization, culture and situational leadership	Be an effective team player	Facilitate change management in the line organization	Coach, counsel and motivate peers and subordinates.		

ANNEX II

Relationship of Courses to Program Outcomes

ANNEX II

RELATIONSHIP OF THE COURSES TO THE PROGRAM OUTCOMES

Program Outcomes

A graduate of the Bachelor of Science in Mechanical Engineering (BSME) program must have attained:

a. An ability to apply knowledge of mathematics, science and engineering
b. An ability to design and conduct experiments, as well as to analyze and interpret data
c. An ability to design a system, component or process to meet desired needs within realistic constraints
d. An ability to function on multi-disciplinary teams
e. An ability to identify, formulate and solve engineering problems
f. An understanding of professional and ethical responsibility
g. An ability to communicate effectively in both Filipino and English languages
h. An understanding of the impact of engineering solutions in a global and societal context
i. An ability to use techniques, skills and modern engineering tools necessary for mechanical engineering practice

Key: [ ] Very little or no emphasis [x] Some, moderate, or substantial emphasis

I. TECHNICAL COURSES

A. Mathematics

Courses	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
College Algebra	x	x	x		x				x
Advanced Algebra	x	x	x		x				x
Plane and Spherical Trigonometry	x	x	x		x				x
Analytic Geometry	x	x	x		x				x
Solid Mensuration	x	x	x		x				x
Differential Calculus	x	x	x		x				x
Integral Calculus	x	x	x		x				x
Differential Equations	x	x	x		x				x
Probability and Statistics	x	x	x		x				x

B. Natural/Physical Sciences

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
General Chemistry	x	x	x		x				x
Physics 1	x	x	x		x				x
Physics 2	x	x	x		x				x

C. Basic Engineering Sciences

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
Engineering Drawing	x	x	x		x				x
Computer Fundamentals and Programming	x	x	x		x				x
Computer –Aided Drafting	x	x	x		x				x
Statics of Rigid Bodies	x	x	x		x				x
Dynamics of Rigid Bodies	x	x	x		x				x
Mechanics of Deformable Bodies	x	x	x		x				x
Engineering Economy	x	x	x	x	x	x		x	x
Engineering Management	x	x	x	x	x	x	x	x	x
Environmental Engineering	x	x	x		x	x		x	x
Safety Management				x		x	x	x	x

D. Allied Courses

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
Basic Electrical Engineering	x	x	x		x				x
Basic Electronics	x	x	x		x				x
DC and AC Machinery	x	x	x		x				x

E. Fundamental Mechanical Engineering Courses

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
Orientation to ME	x	x	x	x	x	x	x	x	X
Advanced Engineering Mathematics for ME	x	x	x		x				x
Methods of Research for ME	x	x	x	x	x	x	x	x	x
Fluid Mechanics	x	x	x		x				x
Machine Elements 1	x	x	x		x			x	x
Machine Elements 2	x	x	x		x			x	x
Materials Engineering	x	x	x		x			x	x
Thermodynamics 1	x	x	x		x			x	x
Thermodynamics 2	x	x	x		x			x	x
Combustion Engineering	x	x	x		x			x	x
Heat Transfer	x	x	x		x			x	x
ME Laboratory 1	x	x	x	x	x	x	x	x	x
ME Laboratory 2	x	x	x	x	x	x	x	x	x
Industrial Processes	x	x	x		x			x	x
Safety Engineering for ME				x		x	x	x	x
Workshop Theory and Practice	x	x	x	x	X				x
Machine shop Theory	x	x	x	x	x			x	x
Instrumentation and Control Engineering	x	x	x		x			x	x
Fluid Machinery	x	x	x		x			x	x
Refrigeration Systems	x	x	x		x			x	x
Airconditioning and Ventilation Systems	x	x	x		x	x		x	x
Vibration Engineering	x	x	x		x			x	x

F. Professional Mechanical Engineering Courses

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
Machine Design 1	x	x	x	x	x	x		x	x
Machine Design 2	x	x	x	x	x	x		x	x
ME Laboratory 3	x	x	x	x	x	x	x	x	x
Industrial Plant Engineering	x	x	x	x	x	x		x	x
Power Plant Engineering	x	x	x	x	x	x		x	x
ME Laws, Ethics, Codes and Standards	x	x	x	x	x	x	x	x	x
Plant Visit/OJT				x	x	x	x	x	x
ME Project Study 1	x	x	x	x	x	x	x	x	x
ME Project Study 2	x	x	x	x	x			x	x

G. Electives Courses

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
ME Electives	x	x	x	x	x	x		x	x

II. NON-TECHNICAL COURSES

A. Social Sciences

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
Social Science 1						x	x	x	
Social Science 2						x	x	x	
Social Science 3						x	x	x	
Social Science 4						x	x	x	

B. Humanities

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
Humanities 1						x	x	x	
Humanities 2						x	x	x	
Humanities 3						x	x	x	

C. Languages

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
English 1				x			x		
English 2				x			x		
English 3 (Technical Communication)							x		
Pilipino 1				x			x		
Pilipino 2				x			X		

D. Mandated Course

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
Life and Works of Rizal						x	x		

E. Physical Education

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
P.E. 1, 2,3,4 (2 units each)				x					

F. National Training Service Program

Course	Relationship to Program Outcomes								
	a	b	c	d	e	f	g	h	i
NSTP 1, 2				x		x			

ANNEX IV

LABORATORY REQUIREMENTS

A. Chemistry & physics laboratory

B. Mechanical Engineering Laboratory

A. Chemistry & Physics Laboratory

B. Mechanical Engineering Laboratory

GENERAL CHEMISTRY LABORATORY

Exercise	Required Equipment	Required Quantity*
1. Basic Laboratory Techniques		
a. Use of burner	Burner	5 pcs.
b. Preparation of solutions	Beaker	5 pcs.
• Determination of mass	Graduated cylinder	5 pcs.
• Measurements of volume	Triple beam balance	5 pcs.
• Calculation of density	NaCl solution	25 mL
	$Pb(NO_3)_2$ solution	25 mL
2. Separation techniques	Glass funnel	5 pcs.
a. Filtration/decantation	Beaker	5 pcs.
b. Sublimation	Evaporating dish	5 pcs.
c. Adsorption	Filter stand	5 pcs.
d. Distillation	Distillation apparatus	1 set-up
	Activated charcoal	5 g
	Staple wire	25 pcs.
	Food color	5 g
	$KMnO_4$ solution	25 mL
3. Classification of matter	Test tube	50 pcs.
a. Differentiation of elements, compounds mixtures, colloids	pH paper	20 pcs.
	Conductivity apparatus	1 set-up
b. Differentiation of electrolyte from non-electrolyte	I_2 crystals	3 g
	$KClO_3$ solid	3 g
c. Differentiation of acid, bases, salts.	NaOH solution	25 mL
	HCl solution	25 mL
	NaCl solution	25 mL
	Sugar solution	25 mL
4. Changes of matter and energy transformation	Test tube	50 pcs.
a. Differentiation of physical from chemical change	Burner	5 pcs.
	Evaporating dish	5 pcs.
b. Law of conservation of mass	Beaker	5 pcs.
c. Types of chemical reactions	Alcohol	5 mL
	I_2 crystals	5 g
	Zn strips	5 pcs.
	HCl solution	25 mL
	Staple wire	25 pcs.
	$CuSO_4$ solution	25 mL
5. Gas Laws	Beaker	5 pcs.
a. Boyle's Law	Thermometer	5 pcs.
b. Charles's Law	Syringe	5 pcs.
c. Graham's Law	Glass tubing	5 pcs.
	Sand bag	5 pcs.
	NH_4OH solution	5 mL
	HCl solution	5 mL
6. Solutions	Test tube	50 pcs.
a. Factors affecting solubility	Beaker	5 pcs.
b. Colligative properties	Alcohol	25 mL

	Hexane Sugar NaCl Urea Oil	25 mL 5 g 5 g 5 g 5 mL
7. Rates of chemical reactions, chemical equilibrium	Test tube Beaker Mg ribbon HCl solution $FeCl_3$ solution KSCN solution KCl solution Fe $(NO_3)_3$ solution	50 pcs. 5 pcs. 5 pcs. 25 mL 25 mL 25 mL 25 mL 25 mL
8. Redox reaction and electrochemistry	Battery Test tube Zn strips Cu strips Pb strips Pb $(NO_3)_2$ solution Zn $(NO_3)_2$ solution Alligator clip	5 pcs. 50 pcs. 5 pcs. 5 pcs. 5 pcs. 25 mL 25 mL 10 pcs.
9. Corrosion	Petri dish Battery Alligator clip Cu strips Zn strips Al strips Mg strips Electrolyte solution	5 pcs. 5 pcs. 10 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 25 mL

* Required Quantity is based on a class size of 25 students

PHYSICS 1 LABORATORY

Exercise	Required Equipment	Required Quantity*
1. An exercise to illustrate the principles, use, and precision of the vernier caliper and micrometer caliper	Ruler Vernier caliper Micrometer caliper Objects for measuring	5 pcs. 5 pcs. 5 pcs. 5 sets
2. An exercise to verify the graphical and analytical methods of determining resultant forces.	Force table Weight holder Masses Meter stick Protractor	5 pcs. 20 pcs. 5 sets 5 pcs. 5 pcs.

	Alternate apparatus: Force frame Spring balance Weight holder Masses Ruler	 5 pcs. 15 pcs. 15 pcs. 5 sets 5 pcs.
3. An exercise to observe and verify the elements of motion along the straight line	Linear air track with blower and trolley Timer/stopwatch Meter stick Free fall apparatus Metal balls of different sizes Clamp Support rod *Alternate apparatus:* Spark timer/ticker timer Paper tape Stopwatch Plane board with stand Clamp Wooden cart Scissors Carbon paper Masking tape Meter stick	5 pcs. 5 pcs. 5 pcs. 5 pcs. 12 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 1 set 5 pcs.
4. An exercise to observe and verify the elements of motion in two dimensions	Blackwood ballistic pendulum Metal ball Meter stick Carbon paper Inclined plane Protractor *Alternate apparatus:* Projectile apparatus Metal ball/plastic solid ball Photogate Timer/stopwatch Time of flight receptor pad Carbon paper White paper Meter-stick	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
5. An exercise to verify the laws of motion	Atwood's machine Masses Stopwatch String *Alternate apparatus:* Frictionless dynamic track Smart pulley Stopwatch Weight holder	5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.

	String Clamp	5 pcs. 5 pcs.
6. An exercise to determine the coefficients of static and kinetic friction of various surfaces	Friction board with pulley Friction block with different surfaces Glass plate of size similar to friction board Platform/triple beam balance Weight holder Meter stick Slotted masses, 5-500g	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets
7. An exercise to verify the work-energy theorem	Dynamic cart Frictionless dynamic track Masses Weight holder Clamp String Timer/stopwatch Platform/triple beam balance Support rod	5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
8. An exercise to verify the principles of conservation of mechanical energy	Metal stand Clamp Metal ball String Meter stick Cutter blade Hanging mass Carbon paper White paper Masking tape	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 10 pcs. 10 pcs. 1 set
9. An exercise to verify the principles of conservation of momentum	Ramp/launcher Metal stand Clamp Metal balls of different sizes Meter stick Carbon paper White paper Masking tape	5 pcs. 5 pcs. 5 pcs. 10 pcs. 5 pcs. 10 pcs. 10 pcs. 1 set
10. An exercise to verify the condition of the body in rotational equilibrium	Demonstration balance Vernier caliper Platform/triple beam balance Masses Meter stick	5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs.
11. An exercise to verify the forces involved in uniform circular motion	Centripetal force apparatus Meter stick Mass with hook Platform/triple beam balance Stopwatch	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.

12. An exercise to verify the principle of simple harmonic motion	Clamp Masses Weight holder Meter stick Support rod Spring *Alternate apparatus:* Hooke's Law apparatus	5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
13. An exercise to measure specific gravity	*Liquids:* Hydrometer jar U-tube Inverted U-tube Beaker Masses Meter stick Vernier caliper Specimen of liquids *Solids*: Beam balance Hydrometer jar Beaker Thread Thermometer Specimen of solids *Alternate apparatus:* Mohr-Westpal Balance	 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs.
14. An exercise to observe and verify the elements of transverse wave motion	Sonometer Weight holder Set of masses Tuning forks of three different frequencies Rubber hammer Meter stick	5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs.

* Required Quantity is based on a class size of 25 students

PHYSICS 2 LABORATORY

Exercise	Required Equipment	Required Quantity*
1. An exercise to determine the specific heats of solids by the methods of mixture	Calorimeter Stirrer for shot Specimen for shot Thermometer Platform/triple beam balance Beaker	5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs.

	Ice Water	5 sets
2. An exercise to measure the coefficient of linear expansion	Thermal expansion apparatus Steam generator Ohmmeter/VOM Connectors Basin/container Hot and cold water	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
3. An exercise to measure the mechanical equivalent of heat	Mechanical equivalent of heat apparatus Ohmmeter/VOM Mass (10 kg) Thermometer Vernier caliper Platform/triple beam balance	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
4. An exercise to observe and verify the elements of electric charge	Van de Graff generator Tissue paper Aluminum foil Metal conductor with insulated handle Fluorescent lamp Masking Tape Power Source Galvanometer Conducting paper Field mapper kit/mapping Apparatus Connectors	2 sets 2 sets 2 sets 2 sets 2 sets 1 set 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets
5. An exercise to illustrate Ohm's Law	Panel board/circuit board VOM or multitester DC power supply Bridging plugs/connecting wires Fixed resistor SPST switch SPDT switch *Alternate apparatus:* Bread board Jumper	5 pcs. 5 pcs. 5 pcs. 5 sets 15 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets
6. An exercise to determine and compare the resistance of different conductors	1-m slide wire/ wheatstone bridge Power supply VOM or multitester Galvanometer Potentiometer Fixed resistor Unknown resistor SPST switch Connecting wires	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets

7. An exercise to verify the principles of series and parallel connections	Panel board/circuit board VOM or multitester DC power supply Bridging plugs/connecting wires Fixed resistors *Alternate apparatus:* Bread board Jumper	5 pcs. 5 pcs. 5 pcs. 5 sets 15 pcs. 5 pcs. 5 sets
8. An exercise to verify the relationship among the electromotive force, current, and resistance of cells in series and parallel	Dry cells Switch VOM or multitester Resistors Panel board/circuit board Bridging plugs/connecting wires *Alternate apparatus:* Bread board Jumper	10 pcs. 5 pcs. 5 pcs. 10 pcs. 5 pcs. 5 sets 5 pcs. 5 sets
9. An exercise to observe the applications of Kirchhoff's Law	Power supply Fixed resistors VOM or multitester Bridging plugs/connecting wires Panel board/circuit board *Alternate apparatus:* Bread board Jumper	10 pcs. 25 pcs. 10 pcs. 5 sets 5 pcs. 5 pcs. 5 sets
10. An exercise to determine the electrical equivalent of heat	Electric calorimeter Thermometer Beam balance Masses Stop watch VOM or multitester Rheostat DC power source Connecting wires Switch	5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs.
11. An exercise to observe the relationships between resistance and capacitance in the circuit	Power source Fixed capacitor (330 microfarad) Fixed Resistor (100 ohms) Connecting wires VOM or multitester Stopwatch	5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs.
12. An exercise to observe the principle of magnetic field	Natural magnets Horseshoe magnets Bar magnets	5 pcs. 5 pcs. 10 pcs.

	Ring Glass plate Iron fillings Frame for bar magnets Compass Mounted straight wire Coil Solenoid Battery Reversing switch *Alternate apparatus:* Tesla meter / tangent galvanometer	5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 2 sets
13. An exercise to demonstrate the Faraday's law of electromagnetic induction	Coils Galvanometer VOM or multitester AC power supply Bar magnets Connecting wires	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
14. An exercise to verify the law of reflection and refraction	Optics bench Light source, sodium/mercury lamps Ray table and base Component holder Slit plate Slit mask Ray optics mirror Cylindrical lens	5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.
15. An exercise to investigate and study the image formation in mirror and lenses	Optic bench Light source Ray table and base Component holder Parallel ray lens Slit plate Ray optics mirror 5 cm focal length spherical mirror -15cm focal length concave lens 10cm/7.5 cm focal length convex lens 15 cm focal length convex lens Viewing screen Crossed arrow target	5 pcs. 5 pcs. 5 pcs. 15 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.

* Required Quantity is based on a class size of 25 students

BASIC ELECTRICAL ENGINEERING

Recommended Experiments/Exercises

1. Familiarization with DC instruments
2. OHM's Law and resistor color coding
3. Series and parallel circuits
4. Power in Dc circuits
5. Delta - Wye Transfromations
6. Kirchhoffs's Laws
7. Superposition Theorem
8. Thevenin's and Norton's Theorem
9. Maximum power transfer in DC circuits
10. RC time constant

Laboratory Equipment/Apparatus Required

SPECIFICATIONS	UNITS	QTY
Circuit boards 1 and 2	sets	4
Metering board	pcs	4
VOM (analog and digital)	pcs	4
Regulated power supply	sets	8
Connecting wire		
Lamp loads	sets	4
Wattmeter	pcs	4
Variac	pcs	4
Battery (9 V)		
Bread board	pcs	4
Stop watch	pcs	4
SPST switch	pcs	4
Resistors (1 W)		
Electrolytic Capacitor (12 V)		

BASIC ELECTRONIC ENGINEERING

Recommended Experiments/Exercises

1. Diode test and familiarization
2. Clipper and clamper on waveshaping circuits
3. Capacitor - filtered and power supply
4. Transistor familiarization
5. Transistor application
6. JFET familiarization and characteristics curves
7. Amplifiers (types and applications)
8. Operational amplifier (basic characteistics)

Laboratory Equipment/Apparatus Required

SPECIFICATIONS	UNITS	QTY
Signal generators	pcs	4
Function generators	pcs	4
Oscilloscopes	pcs	4
DC power supply	pcs	10
Multimeters	pcs	5
Bread board/experiment board		
Connecting wires		
Multi-input transformers	pcs	4

WORKSHOP THEORY AND PRACTICE

Recommended Experiments/Exercises to be performed.

1. Metrology
2. Lay out and Pattern Making
3. Bench Work
4. Sheet Metal Works
5. Welding Practice
6. Forging
7. Foundry/Casting/Pattern Making

Laboratory Equipment/Apparatus Required

1. Hand Tools	-	5 sets/type
2. Power Tools	-	5 sets/type
3. Driving Tools	-	5 sets/type
4. Wood working equipment		
4.1 Planner (wood)	-	1 set
4.2 Sander	-	1 set
4.3 Circular Saw	-	1 set
4.4 Wood Lathe	-	1 set
5. Cutting Hand Tools	-	5 sets/type
6. Work holding tools	-	5 sets/type
7. Bar cutter	-	1 set
8. Cut-off grinding wheel	-	1 set
9. Sheet Metal tools	-	2 sets/type
10.Welding Machine/tools		
10.1 Arc	-	2 units
10.2 Gas	-	1 set
10.3 Inert Gas TIG & MIG	-	1 set each
11. Forging Tools and Furnace	-	5 sets of tools & 1 set furnace
12. Foundry Tools	-	5 sets of tools
13. Cupola-crucible type	-	1 set
14. Measuring Instruments/Tools	-	5 sets/type

MACHINE SHOP THEORY

Recommended Experiments/Exercises to be performed

1. Lathe Works
2. Shaper/Planner and Milling Works
3. Grinding Works
4. CNC Machining (Basic Programming)

Laboratory Equipment/Apparatus Required

1. Lathe Machines (manual and/or numerical controlled)
2. Shapers
3. Milling Machines
4. Bench Grinder
5. Surface Grinder
6. Cylindrical Grinder
7. Drill Press
8. Power Hack Saw

ME LABORATORY 1

Recommended Experiments/Exercises

1. Measurement of Length, Area and Speed
2. Calibration of Platform Scale
3. Calibration of Water Tank, Meter and Orifice
4. Calibration and use of Pressure and Temperature Measuring Instruments
5. Velometers and Pitot Test
6. Measurement of Humidity
7. Specific Gravity and Viscosity of Fuels/Lubricants
8. Flash and fire points of liquid fuels and grease
9. Carbon Residue Test
10. Oxygen Bomb Calorimeter
11. Flue Gas Analysis

Laboratory Equipment/Apparatus Required

1. Planimeter
2. Dead Weight Tester
3. Vacuum Gauge Tester
4. Variable Speed Tester
5. Viscometer
6. Sliding block viscometer (Newton's Law)
7. Temp. Comparison Bath
8. Bomb Calorimeter
9. Orsat Apparatus
10. Hygrometer
11. Set of Pitot Tubes
12. Set of U-tube manometers
13. Set of Calipers
14. Set of flowmeters
15. Set of Weights
16. Platform Scale (100 kg)
17. Flash & Fire Points Apparatus

ME LABORATORY 2

Recommended Experiments/Exercises

1. Performance test and various pumps, blowers and compressors (Ex. Centrifugal pump performance test)

2. Measurement of Boiler Heating Surface
3. Heat Losses through pipes
4. Performance test of SI & CI engine

List of Equipment/Apparatus Required

1. Centrifugal, Axial, Gear and piston pump test rig
2. 4 sets of fans/blowers test rig
3. Air compressor test rig
4. Boiler & steam turbine
5. Bare and logged pipe
6. Diesel Engine Performance test bed
7. Gasoline Engine Performance test bed
8. Surface and Tubular Condensers
9. Reynolds Apparatus

ME LABORATORY 3

Recommended Experiments/Exercises

1. Expt. No. 1-4 Analysis & Performance test of Refrigeration system
2. Expt. 5 Mini-Ice plant analysis & performance test
3. Expt. 6-9 Analysis and Performance test of Air conditioning system
4. Expt. 10-12 Steam plant operation analysis/and performance test

Laboratory Equipment/Apparatus Required

1. Refrigeration Trainer
2. Air Conditioning Trainer
3. Ice Plant
4. Mini Steam Plant
5. Fluid-Power Equipment
6. Diesel Engine

MATERIALS AND ENGINEERING LABORATORY

Recommended Experiments/Exercises

1. Tensile strength determination
2. Compression strength determination
3. Shear strength determination
4. Flexural strength determination
5. Torsional shear strength determination
6. Fatigue strength determination
7. Hardness determination

List of Equipment/Apparatus Required

1. BHN Testing Machine
2. Beam Deflection Machine
3. Rotary Bending, Fatigue Testing Machine
4. Universal Testing Machine (UTM)
5. Shear Test
6. Magnetic Particle Test
7. Impact Test

DC AND AC MACHINERY

Recommended Experiments/Exercises

1. DC Motor Performance Test
2. DC Generator Performance Test
3. Single Phase supply & transformer connection
4. Three Phase supply & transformer connection
5. Squirrel Cage Induction Motor Performance Test
6. Capacitor start-capacitor run motor Performance Test
7. Synchronous Motor Performance Test
8. Universal Motor Performance Test

List of Equipment/Apparatus Required

1. DC/AC Test Equipment or its Equivalent DC/AC Machine Lab. Setup

INSTRUMENTATION AND CONTROL

Recommended Experiments/Exercises (at least 12 experiments/exercises)

1. Functional tests of sensors
2. Control Systems simulations
3. Pneumatic applications
4. Hydraulics applications
5. Electronic controls
6. Positioners
7. Valves

Laboratory Equipment/Apparatus Required

1. Sensing Equipment
2. Process Controls
3. Fluid Power Equipment
4. Instrumentation Components

ANNEX III

COURSE SPECIFICATIONS

ANNEX III

COURSE SPECIFICATIONS FOR BSME

TABLE OF CONTENTS

COURSE SPECIFICATIONS
Bachelor of Science in Mechanical Engineering

1. TECHNICAL COURSES

A. MATHEMATICS

Course Name	COLLEGE ALGEBRA
Course Description	Algebraic expressions and equations; solution sets of algebraic equations in one variable: linear, quadratic, polynomial of degree *n*, fractional, radical equations, quadratic in form, exponential and logarithmic equations; decomposition of fractions into partial fractions; solution sets of systems of linear equations involving up to three variables.
Number of Units for Lecture and Laboratory	Lecture- 3 units
Number of Contact Hours per Week	Lecture- 3 hours
Prerequisite	None
Course Objectives	After completing this course, the student must be able to: 1. Operate and simplify algebraic expressions; 2. Determine the solution sets of all types of algebraic equations, exponential and logarithmic equations; and inequalities; 3. Use the manipulative and analytical skills acquired in Objectives 1 to 2 to solve word problems; and 4. Identify the domain and range of a given relation/function.
Course Outline	1. The Set of Real Numbers 1.1. Integer Exponents 1.2. Polynomials, Operations, Special Products 1.3. Binomial Expansion (Binomial Theorem) 1.4. Factoring Polynomials 2. Rational Expressions 2.1. Rules of Exponents; Simplification of Rational Expressions; Operations on Rational Expressions 2.2. Properties of Radicals; Simplification of Radicals 2.3. Operations on Radicals 2.4. Complex Numbers 3. Equations in One Variable 3.1. Linear Equations; Literal Equations 3.2. Quadratic Equations in One Variable 3.3. Word Problems 3.4. Other Equations in One Variable: Radical, Fractional, Quadratic in Form 3.5. Polynomial Equation of Degree *n* 4. Functions 4.1. Inverse Functions 4.2. Exponential and Logarithmic Functions 4.3. Exponential and Logarithmic Equations 5. Systems of Linear Equations (by Elimination Methods) 6. Decomposition of Rational Expressions into Partial Fractions
Laboratory Equipment	None

Course Name	ADVANCED ALGEBRA
Course Description	Matrices and determinants; arithmetic and geometric series; solution sets of different types of inequalities and systems involving quadratics; solution of linear equations using determinants and matrices.
Number of Units for Lecture and Laboratory	Lecture- 2 units
Number of Contact Hours per Week	Lecture- 2 hours
Prerequisites	College Algebra
Course Objectives	After completing this course, the student must be able to: 1. Determine the solution sets of inequalities; 2. Determine the solution sets of systems involving quadratics; 3. Use the manipulative and analytical skills acquired in Objective 2 to solve word problems; 4. Operate and manipulate matrices and determinants; 5. Solve systems of linear equations using matrices and determinants; and 6. Determine the indicated sum of the elements in an arithmetic and geometric sequence.
Course Outline	1. Inequalities 1.1. Linear, Quadratic, and Polynomial Inequality 1.2. Linear Inequalities with Absolute Value 2. Ratio, Proportion, and Variation 3. Determinants 3.1. Expansion by Minors 3.2. Solution of Linear Systems by Cramer's Rule 4. Matrices 4.1. Identity Matrix 4.2. Cofactor Matrix 4.3. Transpose of a Matrix 4.4. Adjoint Matrix 4.5. Inverse of a Matrix 4.6. Algebra on Matrices (Sum and Difference, Scalar Multiplication, Matrix Multiplication) 4.7. Solution of Linear Systems Using Matrices 5. Sequence and Series 5.1. Arithmetic and Geometric Means 5.2. Arithmetic and Geometric Sequences 5.3. Arithmetic and Geometric Series 5.4. Infinite Series 6. Combinatorial Mathematics 6.1. Sequences 6.2. The Factorial of a Number 6.3. Fundamental Principles of Counting, Permutation, and Combination 6.4. Binomial Theorem 6.5. Mathematical Induction
Laboratory Equipment	None

Course Name	PLANE AND SPHERICAL TRIGONOMETRY
Course Description	Trigonometric functions; identities and equations; solutions of triangles; law of sines; law of cosines; inverse trigonometric functions; spherical trigonometry
Number of Units for Lecture and Laboratory	Lecture- 3 units
Number of Contact Hours per Week	Lecture- 3 hours
Prerequisite	None
Course Objectives	After completing this course, the student must be able to: 1. Define angles and how they are measured; 2. Define and evaluate each of the six trigonometric functions; 3. Prove trigonometric functions; 4. Define and evaluate inverse trigonometric functions; 5. Solve trigonometric equations; 6. Solve problems involving right triangles using trigonometric function definitions for acute angles; and 7. Solve problems involving oblique triangles by the use of the sine and cosine laws.
Course Outline	1. Trigonometric Functions 1.1. Angles and Measurement 1.2. Trigonometric Functions of Angles 1.3. Trigonometric Function Values 1.4. The Sine and Cosine of Real Numbers 1.5. Graphs of the Sine and Cosine and Other Sine Waves 1.6. Solutions of Right Triangle 2. Analytic Trigonometry 2.1. The Eight Fundamental Identities 2.2. Proving Trigonometric Identities 2.3. Sum and Difference Identities 2.4. Double-Measure and Half-Measure Identities 2.5. Inverse Trigonometric Functions 2.6. Trigonometric Equations 2.7. Identities for the Product, Sum, and Difference of Sine and Cosine 3. Application of Trigonometry 3.1. The Law of Sines 3.2. The Law of Cosines 4. Spherical Trigonometry 4.1. Fundamental Formulas 4.2. Spherical Triangles
Laboratory Equipment	None

Course Name	**ANALYTIC GEOMETRY**
Course Description	Equations of lines and conic sections; curve tracing in both rectangular and polar coordinates in two-dimensional space.
Number of Units for Lecture and Laboratory	Lecture- 2 units
Number of Contact Hours per Week	Lecture- 2 hours
Prerequisites	College Algebra Plane and Spherical Trigonometry
Course Objectives	After completing this course, the student must be able to: 1. Set up equations given enough properties of lines and conics; 2. Draw the graph of the given equation of the line and the equation of the conic section; and 3. Analyze and trace completely the curve, given their equations in both rectangular and polar coordinates, in two-dimensional space.
Course Outline	1. Plane Analytic Geometry 1.1. The Cartesian Planes 1.2. Distance Formula 1.3. Point-of-Division Formulas 1.4. Inclination and Slope 1.5. Parallel and Perpendicular Lines 1.6. Angle from One Line to Another 1.7. An Equation of a Locus 2. The Line 2.1. Point-Slope and Two-Point Forms 2.2. Slope-Intercept and Intercept Forms 2.3. Distance from a Point to a Line 2.4. Normal Form 3. The Circle 3.1. The Standard Form for an Equation of a Circle 3.2. Conditions to Determine a Circle 4. Conic Sections 4.1. Introduction 4.2. The Parabola 4.3. The Ellipse 4.4. The Hyperbola 5. Transformation of Coordinates 5.1. Translation of Conic Sections 6. Curve Sketching 6.1. Symmetry and Intercepts 6.2. Sketching Polynomial Equations 6.3. Asymptotes (Except Slant Asymptotes) 6.4. Sketching Rational Functions 7. Polar Coordinates 7.1. Polar Coordinates 7.2. Graphs in Polar Coordinates 7.3. Relationships Between Rectangular and Polar Coordinates
Laboratory Equipment	None

Course Name	SOLID MENSURATION
Course Description	Concept of lines and planes; Cavalieri's and Volume theorems; formulas for areas of plane figures, volumes for solids; volumes and surfaces areas for spheres, pyramids, and cones; zone, sector and segment of a sphere; theorems of Pappus.
Number of Units for Lecture and Laboratory	Lecture- 2 units
Number of Contact Hours per Week	Lecture- 2 hours
Prerequisite	College Algebra, Plane and Spherical Trigonometry
Course Objectives	After completing this course, the student must be able to: 1. Compute for the area of plane figures; 2. Compute for the surface areas and volumes of different types of solids; and 3. Determine the volumes and surface areas of solids using other methods such as the theorems of Pappus.
Course Outline	1. Plane Figures 1.1. Mensuration of Plane Figures 2. Lines and Planes in Space 2.1. Typical Proofs of Solid Geometry 2.2. Angles 3. Solids for which V = Bh 3.1. Solid Sections 3.2. Cubes 3.3. Rectangular Parallelopiped 3.4. Cavalieri's Theorem 3.5. Volume Theorem 3.6. Prism 3.7. Cylindrical Surface 3.8. Cylinder (Circular and Right Circular) 4. Solids for which V = ⅓bh) 4.1. Pyramids 4.2. Similar Figures 4.3. Cones 4.4. Frustum of Regular Pyramid 4.5. Frustum of Right Circular Cone 5. Sphere 5.1. Surface Area and Volume 5.2. Zone 5.3. Segment 5.4. Sector 6. Theorems of Pappus
Laboratory Equipment	None

Course Name	DIFFERENTIAL CALCULUS
Course Description	Basic concepts of calculus such as limits, continuity and differentiability of functions; differentiation of algebraic and transcendental functions involving one or more variables; applications of differential calculus to problems on optimization, rates of change, related rates, tangents and normals, and approximations; partial differentiation and transcendental curve tracing.
Number of Units for Lecture and Laboratory	Lecture- 4 units
Number of Contact Hours per Week	Lecture- 4 hours
Prerequisites	Advanced Algebra Analytic Geometry Solid Mensuration
Course Objectives	After completing this course, the student must be able to: 1. Have a working knowledge of the basic concepts of functions and limits; 2. Differentiate algebraic and transcendental functions with ease; 3. Apply the concept of differentiation in solving word problems involving optimization, related rates, and approximation; and 4. Analyze and trace transcendental curves.
Course Outline	1. Functions 1.1. Definitions 1.2. Classification of Functions 1.3. Domain and Range of a Function 1.4. Graph of a Function 1.5. Functional Notation 1.6. Evaluation of a Function 1.7. Combinations of Functions 1.8. One-Valued and Many-Valued Functions 1.9. Odd and Even Functions 1.10. Special Function Types 1.11. Functions as Mathematical Models 2. Continuity 2.1. Definition 2.2. Properties of Continuous Functions 3. Limits 3.1. Notion of a Limit 3.2. Definition 3.3. Properties of Limits 3.4. Operations with Limits 3.5. Evaluation of Limits 3.6. One-Sided Limits 3.7. Unbounded Functions 4. The Derivative 4.1. Notion of the Derivative 4.2. Definition 4.3. Determination of the Derivative by Increments 4.4. Differentiation Rules 5. The Slope 5.1. Definition of Slope as the Derivative of a Function 5.2. Determination of the Slope of a Curve at a Given Point 6. Rate of Change 6.1. Average Rate of Change 6.2. Instantaneous Rate of Change 7. The Chain Rule and the General Power Rule

	8. Implicit Differentiation 9. Higher-Order Derivatives 10. Polynomial Curves 10.1. Generalities About Straight Lines 10.2. Tangents and Normal to Curves 10.3. Extrema and the First Derivative Test 10.4. Concavity and the Second Derivative Test 10.5. Points of Inflection 10.6. Sketching Polynomial Curves 11. Applications of the Derivative: Optimization Problems 12. Applications of the Derivative: Related Rates 13. The Differential 13.1. Definition 13.2. Applications of the Differential—Comparison of Δx and dx 13.3. Error Propagation 13.4. Approximate Formulas 14. Derivatives of Trigonometric Functions 14.1. Elementary Properties 14.2. Definition 14.3. Graphs of Trigonometric Functions 14.4. Applications 15. Derivatives of Inverse Trigonometric Functions 15.1. Elementary Properties 15.2. Definition 15.3. Graphs of Inverse Trigonometric Functions 15.4. Applications 16. Derivatives of Logarithmic and Exponential Functions 16.1. Elementary Properties 16.2. Definition 16.3. Graphs of Logarithmic and Exponential Functions 16.4. Applications 17. Derivatives of Hyperbolic Functions 17.1. Elementary Properties 17.2. Definition 17.3. Graphs of Hyperbolic Functions 17.4. Applications 18. Solution of Equations 18.1. Newton's Method of Approximation 18.2. Newton-Raphson Law 19. Transcendental Curve Tracing 19.1. Logarithmic and Exponential Functions 20. Parametric Equations 21. Partial Differentiation
Laboratory Equipment	None

Course Name	**INTEGRAL CALCULUS**
Course Description	Concept of integration and its application to physical problems such as evaluation of areas, volumes of revolution, force, and work; fundamental formulas and various techniques of integration applied to both single variable and multi-variable functions; tracing of functions of two variables.
Number of Units for Lecture and Laboratory	Lecture- 4 units

Number of Contact Hours per Week	Lecture- 4 hours
Prerequisite	Differential Calculus
Course Objectives	After completing this course, the student must be able to: 1. Properly carry out integration through the use of the fundamental formulas and/or the various techniques of integration for both single and multiple integrals; 2. Correctly apply the concept of integration in solving problems involving evaluation of areas, volumes, work, and force; 3. Sketch 3-dimensional regions bounded by several surfaces; and 4. Evaluate volumes of 3-dimensional regions bounded by two or more surfaces through the use of the double or triple integral.
Course Outline	1. Integration Concept / Formulas 1.1. Anti-Differentiation 1.2. Simple Power Formula 1.3. Simple Trigonometric Functions 1.4. Logarithmic Function 1.5. Exponential Function 1.6. Inverse Trigonometric Functions 1.7. Hyperbolic Functions 1.8. General Power Formula 1.9. Constant of Integration 1.10. Definite Integral 2. Integration Techniques 2.1. Integration by Parts 2.2. Trigonometric Integrals 2.3. Trigonometric Substitution 2.4. Rational Functions 2.5. Rationalizing Substitution 3. Application 3.1. Improper Integrals 3.2. Plane Area 3.3. Areas Between Curves 4. Other Applications 4.1. Volumes 4.2. Work 4.3. Hydrostatics Pressure and Force 5. Surfaces Multiple Integral as Volume 5.1. Surface Tracing: Planes 5.2. Spheres 5.3. Cylinders 5.4. Quadratic Surfaces 5.5. Double Integrals 5.6. Triple Integrals 6. Multiple Integral as Volume 6.1. Double Integrals 6.2. Triple Integrals
Laboratory Equipment	None

Course Name	DIFFERENTIAL EQUATIONS
Course Description	Differentiation and integration in solving first order, first-degree differential equations, and linear differential equations of order *n*; Laplace transforms in solving differential equations.
Number of Units for Lecture and Laboratory	Lecture- 3 units
Number of Contact Hours per Week	Lecture- 3 hours
Prerequisite	Integral Calculus
Course Objectives	After completing this course, the student must be able to: 1. Solve the different types of differential equations; and 2. Apply differential equations to selected engineering problems.
Course Outline	1. Definitions 1.1. Definition and Classifications of Differential Equations (D.E.) 1.2. Order Degree of a D.E. / Linearity 1.3. Solution of a D.E. (General and Particular) 2. Solution of Some 1st Order, 1st Degree D.E. 2.1. Variable Separable 2.2. Homogeneous 2.3. Exact 2.4. Linear 2.5. Equations Linear in a Function 2.6. Bernoulli's Equation 3. Applications of 1st Order D. E. 3.1. Decomposition / Growth 3.2. Newton's Law of Cooling 3.3. Mixing (Non-Reacting Fluids) 3.4. Electric Circuits 4. Linear D.E. of Order *n* 4.1. Standard Form of a Linear D.E. 4.2. Linear Independence of a Set of Functions 4.3. Differential Operators 4.4. Differential Operator Form of a Linear D.E. 5. Homogeneous Linear D.E. with Constant Coefficients 5.1. General Solution 5.2. Auxiliary Equation 6. Non-Homogeneous D.E. with Constant-Coefficients 6.1. Form of the General Solution 6.2. Solution by Method of Undetermined Coefficients 6.3. Solution by Variation of Parameters
Laboratory Equipment	None

Course Name	PROBABILITY AND STATISTICS
Course Description	Basic principles of statistics; presentation and analysis of data; averages, median, mode; deviations; probability distributions; normal curves and applications; regression analysis and correlation; application to engineering problems.
Number of Units for Lecture and Laboratory	Lecture- 3 units

Number of Contact Hours per Week	Lecture- 3 hours
Prerequisite	College Algebra
Course Objectives	After completing this course, the student must be able to: 1. Define relevant statistical terms; 2. Discuss competently the following concepts: 2.1. Frequency distribution 2.2. Measures of central tendency 2.3. Probability distribution 2.4. Normal distribution 2.5. Inferential statistics 3. Apply accurately statistical knowledge in solving specific engineering problem situations.
Course Outline	1. Basic Concepts 1.1. Definition of Statistical Terms 1.2. Importance of Statistics 2. Steps in Conducting a Statistical Inquiry 3. Presentation of Data 3.1. Textual 3.2. Tabular 3.3. Graphical 4. Sampling Techniques 5. Measures of Central Tendency 5.1. Mean 5.2. Median 5.3. Mode 5.4. Skewness and Kurtosis 6. Measures of Variation 6.1. Range 6.2. Mean Absolute Deviation 6.3. Variance 6.4. Standard Deviation 6.5. Coefficient of Variation 7. Probability Distributions 7.1. Counting Techniques 7.2. Probability 7.3. Mathematical Expectations 7.4. Normal Distributions 8. Inferential Statistics 8.1. Test of Hypothesis 8.2. Test Concerning Means, Variation, and Proportion 8.3. Contingency Tables 8.4. Test of Independence 8.5. Goodness-of-Fit Test 9. Analysis of Variance 10. Regression and Correlation
Laboratory Equipment	None

B. NATURAL/PHYSICAL SCIENCES

Course Name	**GENERAL CHEMISTRY**
Course Description	Basic concepts of matter and its classification; mass relationships in chemical reactions; properties of gases, liquids, and solids; concepts of thermochemistry; quantum theory and electronic behavior; periodic relationship of elements in the periodic table; intramolecular forces; and solutions.
Number of Units for Lecture and Laboratory	4 units: Lecture- 3 units Laboratory - 1 unit
Number of Contact Hours per Week	6 hours: Lecture- 3 hours Laboratory - 3 hours
Prerequisite	None
Course Objectives	After completing this course, the student must be able to: 1. Apply significant figures and appropriate units in all measurements and calculations; 2. Classify matter; distinguish between physical and chemical properties/changes; 3. Define and explain the concepts of atomic mass, average atomic mass, mole, molar mass and perform calculations involving these; 4. Balance and interpret chemical equations and perform stoichiometric calculations; 5. Write, explain and apply the gas laws; 6. Discuss the kinetic molecular theory (KMT) of gases and use the KMT to qualitatively explain the gas laws; argue the differences between ideal and non-ideal gas behavior; 7. Define enthalpy; classify common processes as exothermic or endothermic and know the sign conventions; 8. Trace the various atomic theories; discuss the Bohr model; and explain the line spectra of hydrogen; Discuss the concept of electron density; contrast the Bohr's orbits with orbitals in the quantum theory; 9. Write electron configurations and orbital diagrams for multi electron atoms; 10. Use the periodic table to classify elements and predict trends in properties; 11. Write Lewis dot symbols and Lewis structure; 12. Explain valence bond theory, hybrid orbitals, and hybridization in common compounds 13. Distinguish between inter- and intramolecular forces; give examples of intramolecular forces and how they relate to physical properties; 14. Distinguish between crystalline and amorphous solids 15. Discuss various physical changes and interpret phase diagrams; 16. Distinguish different types of solutions; work with different concentration units; Understand the effect of temperature and pressure on solubility; and 17. Explain and apply colligative properties to determine molar mass.
Course Outline	1. The Study of Change 1.1. Introduction to Chemistry 1.2. Matter: Classification, States, Physical, and Chemical Properties 1.3. Measurement and Handling of Numbers 2. Atoms, Molecules, and Ions 2.1. The Atomic Theory 2.2. The Structure of the Atom 2.3. Atomic Number, Mass Number, Isotopes 2.4. The Periodic Table 2.5. Molecules and Ions

	2.6. Chemical Formulas 2.7. Naming Compounds 3. Mass Relationships in Chemical Reaction 3.1. Atomic Mass 3.2. Molar Mass of an Element and Avogadro's Number 3.3. Molecular Mass 3.4. Percent Composition of Compounds 3.5. Chemical Reactions and Chemical Equations 3.6. Amounts of Reactants and Products 3.7. Limiting Reagents 3.8. Reaction Yield 4. Gases 4.1. Substances That Exist as Gases 4.2. Pressure of a Gas 4.3. The Gas Laws 4.4. The Ideal Gas Equation 4.5. Gas Stoichiometry 4.6. Dalton's Law of Partial Pressure 4.7. The Kinetic Molecular Theory of Gases 4.8. Deviation from Ideal Behavior 5. Thermochemistry 5.1. Energy Changes in Chemical Reactions 5.2. Introduction to Thermodynamics 5.3. Enthalpy 6. Quantum Theory and the Electronic Structure of Atoms 6.1. From Classical Physics to Quantum Theory 6.2. Bohr's Theory of the Hydrogen Atom 6.3. The Dual Nature of the Electron 6.4. Quantum Mechanics 6.5. Quantum Numbers 6.6. Atomic Orbitals 6.7. Electron Configuration 6.8. The Building-Up Principle 7. Periodic Relationships Among the Elements 7.1. Periodic Classification of the Elements 7.2. Periodic Variation in Physical Properties 7.3. Ionization Energy 7.4. Electron Affinity 8. Chemical Bonding: Basic Concepts 8.1. Lewis Dot Structure 8.2. The Ionic Bond 8.3. The Covalent Bond 8.4. Electronegativity 8.5. Writing Lewis Structure 8.6. The Concept of Resonance 8.7. Bond Energy 9. Chemical Bonding: Molecular Geometry and Hybridization 9.1. Molecular Geometry 9.2. Dipole Moments 9.3. The Valence Bond Theory 9.4. Hybridization of Atomic Orbitals 9.5. Hybridization in Molecules Containing Double and Triple Bonds 10. Intermolecular Forces in Liquids and Solids 10.1. The KMT of Liquids and Solids 10.2. Intermolecular Forces 10.3. Properties of Liquids 10.4. Crystalline vs. Amorphous Solids 10.5. Phase Changes

	10.6. Phase Diagrams 11. Physical Properties of Solutions 11.1. Types of Solutions 11.2. A Molecular View of the Solution Process 11.3. Concentration Units 11.4. Effect of Temperature and Pressure on Solubility 11.5. Colligative Properties
Laboratory Equipment	Chemistry Laboratory (see ANNEX IV)

Course Name	**PHYSICS 1**
Course Description	Vectors; kinematics; dynamics; work, energy, and power; impulse and momentum; rotation; dynamics of rotation; elasticity; and oscillation.
Number of Units for Lecture and Laboratory	4 units: Lecture- 3 units Laboratory - 1 unit
Number of Contact Hours per Week	6 hours: Lecture- 3 hours Laboratory - 3 hours
Prerequisites	College Algebra Plane and Spherical Trigonometry
Course Objectives	After completing this course, the student must be able to: 1. Differentiate a vector from a scalar; 2. Determine the resultant of concurrent vectors; 3. Solve problems in kinematics; 4. Apply Newton's Laws of Motion; 5. Determine the gravitational force between different masses; 6. Solve problems involving centripetal force for horizontal and vertical curves; 7. Compute the work done on a given body; 8. Relate work and energy; 9. Solve problems by applying the law of conservation of energy; 10. Solve problems in impulse and momentum and collisions; 11. Determine the stress and strain on a body; and 12. Determine the period of a body in simple harmonic motion.
Course Outline	1. Work, Energy and Power 1.1. Definition of Work, Energy and Power 1.2. Conservation of Energy 2. Impulse and Momentum 2.1. Definition of Impulse and Momentum 2.2. Conservation of Momentum 3. Vector 3.1. Vectors and Scalars 3.2. Graphical Method 3.3. Analytical Method 4. Vector Subtraction 5. Kinematics 5.1. Equations of Kinematics 5.2. Freely Falling Bodies 5.3. Projectile Motion 6. Dynamics 6.1. Newton's Laws of Motion 6.2. Friction

	6.3. First Condition of Equilibrium 7. Work, Energy and Power 7.1. Definition of Work, Energy and Power 7.2. Conservation of Energy 8. Impulse and Momentum 8.1. Definition of Impulse and Momentum 8.2. Conservation of Momentum 8.3. Collisions, Coefficient of Restitution 9. Rotation 9.1. Definition of torque 9.2. Second Condition of Equilibrium 9.3. Center of Gravity 10. Dynamics of Rotation 10.1. Kinematics of Rotation 10.2. Dynamics of Rotation 10.3. Center of Gravity 11. Elasticity 11.1. Hooke's Law 11.2. Stress and Strain 11.3. Modulus of Elasticity 12. Oscillations 12.1. Definition of Vibration Motion and Simple Harmonic Motion 12.2. Kinematics of Simple Harmonic Motion 12.3. Simple Pendulum
Laboratory Equipment	Physics Laboratory (see ANNEX IV)

Course Name	**PHYSICS 2**
Course Description	Fluids; thermal expansion, thermal stress; heat transfer; calorimetry; waves; electrostatics; electricity; magnetism; optics; image formation by plane and curved mirrors; and image formation by thin lenses.
Number of Units for Lecture and Laboratory	4 units: : Lecture- 3 units Laboratory - 1 unit
Number of Contact Hours per Week	6 hours: Lecture- 3 hours Laboratory - 3 hours
Prerequisite	Physics 1
Course Objectives	After completing this course, the student must be able to: 1. Describe the characteristics of fluids at rest and in motion; 2. Compute the buoyant force on an object immersed in a fluid; 3. Compute the pressure and flow speed of a fluid at any point in a flow tube; 4. Determine the amount of expansion of a given material in relation to temperature change; 5. Determine the change in temperature of a given amount of material that loses or gains; 6. Solve problems about the law of heat transfer; 7. Describe the three methods of heat transfer; 8. Discuss the properties of waves; 9. Describe the modes of vibration of strings and air columns; 10. Solve problems on Doppler Effect; 11. Compute the electric force between electric charges; 12. Compute the electric field due to electric charges; 13. Compute the electric potential due to a charge and electric potential

	energy of charges; 14. Define electric current, electric resistance and voltage; 15. Solve problems on resistance and cells in series and parallel; 16. State Kirchhoff's rules and apply them in a given circuit; 17. Compute the magnetic field of a given current-carrying conductors; 18. Compute the magnetic torque on a current conductor in a magnetic field; and 19. Describe image formation by mirrors and lenses.
Course Outline	1. Fluids 1.1. Pressure, Specific Gravity, Density 1.2. Archimedes' Principle 1.3. Rate of Flow and Continuity Principle 1.4. Bernoulli's Principle 1.5. Torricelli's Theorem 2. Thermal Expansion, Thermal Stress 3. Heat Transfer 4. Calorimetry 4.1. Specific Heat 4.2. Law of Heat Exchange 4.3. Change of Phase 5. Waves 5.1. Types of Waves and Their Properties 5.2. Sounds 6. Electrostatics 6.1. Charge 6.2. Coulomb's Law 6.3. Superposition Principle 6.4. Electric Field Intensity 6.5. Work and Potential 6.6. Capacitors, Dielectrics 7. Electricity 7.1. Current 7.2. Resistance 7.3. EMF 7.4. Ohm's Law 7.5. Energy and Power in Circuits 7.6. Series and Parallel Connections 7.7. Kirchhoff's Rules 8. Magnetism 8.1. Magnetic Field of Moving Changes 8.2. Magnetic Filed of Current Element 8.3. Motion of a Charge in a Magnetic Field 8.4. Biot-Savart Law 8.5. Force on a Moving Charge in a Magnetic Field 8.6. Torque on a Current-Carrying Loop 9. Optics 9.1. Light as Electromagnetic Waves 9.2. Properties of Reflection and Refraction 10. Image Formation by Plane and Curved Mirrors 10.1. Graphical Methods 10.2. Mirror Equation 11. Image Formation by Thin Lenses 11.1. Graphical Methods 11.2. Lens Equation
Laboratory Equipment	Physics Laboratory (see Annex IV)

C. BASIC ENGINEERING SCIENCES

Course Name	ENGINEERING DRAWING
Course Description	Practices and techniques of graphical communication; application of drafting instruments, lettering scale, and units of measure; descriptive geometry; orthographic projections; auxiliary views; dimensioning; sectional views; pictorial drawings; requirements of engineering working drawings; and assembly and exploded detailed drawings.
Number of Units for Lecture and Laboratory	Laboratory- 1 unit
Number of Contact Hours per Week	Laboratory- 3 hours
Prerequisite	None
Course Objectives	After completing this course, the student must be able to: 1. Understand the importance of technical drawing knowledge and skills as applied to the various areas of engineering; 2. Apply the basic concepts of technical drawing and sketching; and 3. Prepare technical drawings.
Course Outline	1. Engineering Lettering 2. Instrumental Figures 3. Geometric Construction 4. Orthographic Projection 5. Dimensioning 6. Orthographic Views with Dimensions and Section View 7. Sectional View 8. Pictorial Drawing 9. Engineering Working Drawings 10. Assembly and Exploded Detailed Drawings
Laboratory Equipment	1. Drafting table 2. Drawing instruments 2.1. One 30-60 degree triangle 2.2. One 45 degree triangle 2.3. One technical compass 2.4. One protractor

Course Name	**COMPUTER FUNDAMENTALS AND PROGRAMMING**
Course Description	Basic information technology concepts; fundamentals of algorithm development; high-level language and programming applications; computer solutions of engineering problems.
Number of Units for Lecture and Laboratory	Laboratory- 2 units
Number of Contact Hours per Week	Laboratory- 6 hours
Prerequisite	Second Year Standing
Course Objectives	After completing this course, the student must be able to: 1. Understand basic information technology concepts;

	2. Use application software and the Internet properly; 3. Acquire proficiency in algorithm development using a high-level programming language; 4. Use the computer as a tool in engineering practice.
Course Outline	1. Introduction to Computers 1.1. Computer Organization 1.2. Number Systems and Data Representation 1.3. Application Software: Word Processing and Spreadsheet 1.4. The Internet 2. Programming 2.1. Algorithm Development 2.2. Programming Fundamentals
Laboratory Equipment	1. Personal computer with: 1.1. Operating system 1.2. Word processing software 1.3. Spreadsheet software 1.4. High-level programming language 1.5. Internet browser and Internet connection

Course Name	**COMPUTER-AIDED DRAFTING**
Course Description	Concepts of computer-aided drafting (CAD); introduction to the CAD environment; terminologies; and the general operating procedures and techniques in entering and executing basic CAD commands.
Number of Units for Lecture and Laboratory	Laboratory- 1 unit
Number of Contact Hours per Week	Laboratory- 3 hours
Prerequisite	Third Year Standing
Course Objectives	After completing this course, the student must be able to: 1. Define the terms related to computer-aided drafting systems; 2. Identify the important tools used to create technical drawings in CAD; 3. Create electronic drawings (e-drawing) using CAD; and 4. Appreciate the usefulness of the knowledge and skills in computer aided drafting as applied in his/her professional development.
Course Outline	1. Introduction to CAD Software 2. CAD Drawing 3. Snapping, Construction Elements 4. Dimensioning 5. Plotting, Inputting Images 6. 3D and Navigating in 3D 7. Rendering
Laboratory Equipment	1. Personal computer with: 1.1. Operating system 1.2. CAD software 2. Printer or plotter

Course Name	STATICS OF RIGID BODIES
Course Description	Force systems; structure analyses; friction; centroids and centers of gravity; and moments of inertia.
Number of Units for Lecture and Laboratory	Lecture- 3 units
Number of Contact Hours per Week	Lecture- 3 hours
Prerequisites	Physics 1, Integral Calculus
Course Objectives	After completing this course, the student must be able to: 1. Understand the principles of equilibrium of particles; 2. Undertake vector operations such as vector cross and dot product; 3. Determine forces of 2D and 3D structures; 4. Understand the principles of static, wedge and belt friction; 5. Determine centroids, center of mass and center of gravity of objects; 6. Determine moment of inertia, mass moment of inertia; and 7. Analyze the stresses of trusses, beams and frames.
Course Outline	1. Introduction to Mechanics; Vector Operations 2. Force Vectors and Equilibrium of Particles 3. Vector Cross and Dot Product 4. Moment of a Force 5. Couples; Moment of a Couple 6. Equivalent Force Systems in 2D and 3D 7. Dry Static Friction, Wedge and Belt Friction 8. Centroid; Center of Mass; and Center of Gravity 9. Distributed Loads and Hydrostatic Forces; Cables 10. Moment of Inertia; Mass Moment of Inertia 11. Trusses; Frames and Machines; Internal Forces 12. Beams; Shear and Bending Moment Diagrams
Laboratory Equipment	None

Course Name	DYNAMICS OF RIGID BODIES
Course Description	Kinetics and kinematics of a particle; kinetics and kinematics of rigid bodies; work energy method; and impulse and momentum.
Number of Units for Lecture and Laboratory	Lecture- 2 units
Number of Contact Hours per Week	Lecture- 2 hours
Prerequisite	Statics of Rigid Bodies
Course Objectives	After completing this course, the student must be able to: 1. Understand the principles governing the motion of particles, velocity and acceleration; 2. Understand the principles of Newton's Second Law and its applications; 3. Understand kinetics of particles in particular energy and momentum methods; and 4. Understand kinematics of rigid bodies, its energy and momentum.
Course Outline	1. Introduction to Dynamics 2. Position, Velocity, and Acceleration 3. Determination of the Motion of the Particles 4. Uniform Rectilinear Motion

	5. Uniformly Accelerated Rectilinear Motion 6. Position Vector, Velocity, and Acceleration 7. Derivatives of Vector Functions 8. Rectangular Components of Velocity and Acceleration 9. Motion Relative to a Frame in Translation 10. Tangential and Normal Components 11. Radial and Transverse Components 12. Motion of Several Particles (Dependent Motion) 13. Kinetics of Particles: Newton's Second Law 13.1. Newton's Second Law of Motion 13.2. Linear Momentum of the Particle, Rate of Change of Linear Momentum 13.3. System of Units 13.4. Equation of Motion 13.5. Dynamic Equilibrium 13.6. Angular Momentum of Particle, Rate of Change of Angular Momentum 13.7. Equations in Terms of Radial and Transverse Components 13.8. Motion Under a Central Force 14. Kinetics of Particles: Energy and Momentum Methods 14.1. Work of Force 14.2. Kinetic Energy of a Particle, Principle of Work and Energy 14.3. Applications of the Principle of Work and Energy 14.4. Potential Energy 14.5. Conservative Forces 14.6. Conservation of Energy 14.7. Principle of Impulse and Momentum 14.8. Impulsive Motion 14.9. Impact 14.10. Direct Central Impact 14.11. Oblique Central Impact 14.12. Problems Involving Energy and Momentum 15. Systems of Particles 15.1. Application of Newton's Second Laws to Motion of a System of Particles 15.2. Linear and Angular Momentum of a System of Particles 15.3. Motion of Mass Center of a System of Particles 15.4. Angular Momentum of a System of Particles About Its Mass Center 15.5. Conservation of Momentum for a System of Particles 15.6. Kinetic Energy of a System of Particles 15.7. Work-Energy Principle. Conservation of Energy for a System of Particles 15.8. Principle of Impulse and Momentum for a System of Particles 16. Kinematics of Rigid Bodies 16.1. Translation 16.2. Rotation About a Fixed Axis 16.3. Equations Defining the Rotation of a Rigid Body About a Fixed Axis 16.4. General Plane Motion 16.5. Absolute and Relative Velocity in Plane Motion 16.6. Instantaneous Center of Rotation in Plane Motion 16.7. Absolute and Relative Acceleration 16.8. Rate of Change of a Vector with Respect to a Rotating Frame 16.9. Plane Motion of a Particle Relative to a Rotating Frame; Coriolis Acceleration 16.10. Motion About a Fixed Point 16.11. General Motion 16.12. Three-Dimensional Motion of a Particle Relative to a Rotating Frame; Coriolis Acceleration

	16.13. Frame of Reference in General Motion 17. Plane Motion of Rigid Bodies: Forces and Accelerations 17.1. Equation of Motions 17.2. Angular Momentum of a Rigid Body in Plane Motion 17.3. Plane Motion of a Rigid Body. D' Alembert's Principle 17.4. Solution of Problems involving the Motion of a Rigid Bodies 17.5. Systems of Rigid Bodies 17.6. Constrained Plane Motion 18. Plane Motion of Rigid Bodies: Energy and Momentum Methods 18.1. Principle of Work and Energy for a Rigid Body 18.2. Work of Forces Acting on a Rigid Body 18.3. Kinetic Energy of a Rigid Body in Plane Motion 18.4 Systems of Rigid Bodies 18.5 Conservation of Energy 18.6 Principle of Impulse and Momentum 18.7 Conservation of Angular Momentum 18.8 Impulsive Motion 18.9 Eccentric Impact
Laboratory Equipment	None

Course Name	**MECHANICS OF DEFORMABLE BODIES**
Course Description	Axial stress and strain; stresses for torsion and bending; combined stresses; beam deflections; indeterminate beams; and elastic instability.
Number of Units for Lecture and Laboratory	Lecture- 3 units
Number of Contact Hours per Week	Lecture- 3 hours
Prerequisite	Statics of Rigid Bodies
Course Objectives	After completing this course, the student must be able to: 1. Understand the concepts of stress and strain; 2. Calculate stresses due to bending, shears, and torsion under plain and combined loading; 3. Analyze statically determinate and indeterminate structures; and 4. Determine the elastic stability of columns.
Course Outline	1. Load Classification 2. Concept of Stress, Normal and Shear Stress 3. Stresses under Centric Loading 4. Stress Concentration 5. Plane Stress 6. Principal Stresses for Plane Stress 7. Mohr's Circle for Plane Stress 8. Deformations, Normal and Shear Strains 9. Material Properties 10. Working Stresses 11. Deformation in a System of Axially Loaded Members 12. Temperature Effects on Axially Loaded Members 13. Statically Indeterminate Members 14. Thin-Walled Pressure Vessel 15. Torsional Stresses; Elastic Torsion Formula 16. Torsional Deformation; Power Transmission

	17. Flexural Stresses by the Elastic Curve 18. Moment Equation Using Singularity Function 19. Beam Deflection by the Double Integration Method 20. Area Moment Theorems 21. Moment Diagram by Parts 22. Beam Deflection by Area Moment Method 23. Statically Indeterminate Beams 24. Buckling of Long Straight Columns 25. Combined Loadings 26. Analysis of Riveted Connections by the Uniform Shear Method 27. Welded Connections
Laboratory Equipment	None

Course Name	**ENGINEERING ECONOMY**
Course Description	Concepts of the time value of money and equivalence; basic economy study methods; decisions under certainty; decisions recognizing risk; and decisions admitting uncertainty.
Number of Units for Lecture and Laboratory	Lecture- 3 units
Number of Contact Hours per Week	Lecture- 3 hours
Prerequisite	Third Year Standing
Course Objectives	After completing this course, the student must be able to: 1. Solve problems involving interest and the time value of money; 2. Evaluate project alternatives by applying engineering economic principles and methods and select the most economically efficient one; and 3. Deal with risk and uncertainty in project outcomes by applying the basic economic decision making concepts.
Course Outline	1. Introduction 1.1. Definitions 1.2. Principles of Engineering Economy 1.3. Engineering Economy and the Design Process 1.4. Cost Concepts for Decision Making 1.5. Present Economy Studies 2. Money-Time Relationships and Equivalence 2.1. Interest and the Time Value of Money 2.2. The Concept of Equivalence 2.3. Cash Flows 3. Basic Economy Study Methods 3.1. The Minimum Attractive Rate of Return 3.2. The Present Worth Method 3.3. The Future Worth Method 3.4. The Annual Worth Method 3.5. The Internal Rate of Return Method 3.6. The External Rate of Return Method 3.7. The Payback Period Method 3.8. The Benefit/Cost Ratio Method 4. Decisions Under Certainty 4.1. Evaluation of Mutually Exclusive Alternatives 4.2. Evaluation of Independent Projects

	4.3. Depreciation and After-Tax Economic Analysis 4.4. Replacement Studies 4.5. Break win Analysis 5. Decisions Recognizing Risk 5.1. Expected Monetary Value of Alternatives 5.2. Discounted Decision Tree Analysis 6. Decisions Admitting Uncertainty 6.1. Sensitivity Analysis 6.2. Decision Analysis Models
Laboratory Equipment	None

Course Name	**ENGINEERING MANAGEMENT**
Course Description	Decision-making; the functions of management; managing production and service operations; managing the marketing function; and managing the finance function.
Number of Units for Lecture and Laboratory	Lecture- 3 units
Number of Contact Hours per Week	Lecture- 3 hours
Prerequisite	Third Year Standing
Course Objectives	After completing this course, the student must be able to: 1. Understand the field of engineering management; 2. Know and apply the different functions of management.
Course Outline	1. Introduction to Engineering Management 2. Decision Making 3. Functions of Management 3.1. Planning / Coordinating 3.2. Organizing 3.3. Staffing 3.4. Communicating 3.5. Motivating 3.6. Leading 3.7. Controlling 4. Managing Product and Service Operations 5. Managing the Marketing Function 6. Managing the Finance Function
Laboratory Equipment	None

Course Objectives	After completing this course, the student must be able to: 1. Understand the importance and the value of safety; 2. Know the health hazards and their prevention; 3. Identify and mitigate or prevent hazards; and 4. Apply the concepts and principles of safety in engineering practice.
Course Outline	1. Overview of Safety 2. Basic Safety Procedures in High Risk Activities and Industries 2.1. Procedure in Hazards Analysis in the Workplace 2.2. Control of Hazardous Energies 2.3. Confined Space Entry 2.4. Basic Electrical Safety 2.5. Fall Protection 2.6. Barricades and Scaffolds 2.7. Fire Safety and the Fire Code 2.8. Industrial Hygiene 2.9. Hazard Communication and Chemical Safety 3. Value Based Safety and Off-the-Job Safety 3.1. Safety as a Value; Choice vs. Compliance 3.2. Off-the-Job Safety (Residences and Public Places) 3.3. Safety as Related to Health Practices 4. Disaster Prevention and Mitigation 4.1. Rationale for Disaster Prevention and Loss Control 4.2. Planning for Emergencies 4.3. Emergency Response Procedures 5. Incident Investigation and Reporting 5.1. Accident Escalation, Incident Investigation and Reporting 5.2. Causal Analysis; Recognition of Root Cause 5.3. Identification of Corrective or Preventive Actions
Laboratory Equipment	None

D. ALLIED COURSES

Course Name	BASIC ELECTRICAL ENGINEERING
Course Description	This course covers the fundamentals of both DC and AC circuits intended for non EE major students. It covers the principles, basic laws and theorems used in analyzing electrical circuits in both direct current and alternating current conditions.
Number of Units for Lecture and Laboratory	Lecture- 2 units Laboratory -1 unit
Number of Contact Hours per Week	Lecture- 2 hours Laboratory - 3 hours
Prerequisites	Physics 2
Course Objectives	After completing this course, the student must be able to: 1. Gain knowledge about the characteristics, uses and application of circuit elements/devices and their parameters. 2. Apply the fundamental circuit laws, theorems and techniques used in DC and AC circuit analysis. 3. Determine experimentally the laws and theorems used in circuit analysis. 4. Use the voltmeter, ammeter and ohmmeter. 5. Familiarized themselves with the basic circuit elements such as voltage source and resistors.
Course Outline	1. Definitions, symbols used and types of circuit elements, circuit variables and circuit parameters. 2. Resistance 2.1 Definition, Factor that affect the resistance of a conductor, Resistivity of commonly used conductors, Resistance as a function of temperature, Conductance 3. Ohm's Law, Electrical Power, Electrical Energy 4. Heating Effect of Electric Current 5. Connection of Resistors 5.1 Characteristics of Resistors in Series 5.2 Characteristics of Resistors in Parallel 5.3 Characteristics of Resistors in Series – Parallel 5.4 Application of Series and Parallel Connection of Resistors to Meters (D'Arsonval Movement, 5.5 DC Ammeter Circuit, DC Voltmeter Circuit) 6. Network Reduction (Delta Wye Transformation, Wye to Delta Transformation 7. Maximum Power Transfer in DC Circuits 8. Cells and Batteries 8.1 Electrochemical Cells 8.2 Battery Cells in Series 8.3 Battery Cells in Parallel 8.4 Series – Parallel Grouping of Cells 8.5 Battery as a Source of Energy

	9. Laws, Theorems and Methods Used in Network Analysis 9.1 Kirchhoff's Laws 9.2 Maxwells Mesh Method 9.3 Superposition Theorem 9.4 The Yenin's Theorem 9.5 Norton's Theorem 10. Inductors 11. Capacitors 11.1 Altenating current Circuits 11.2 Definition of AC 11.3 Nomeclature of Periodic Waves 11.4 Equations of Continuous Sinusoidal Current and Voltage 11.5 Waves 11.6 Phase Angle, Phase Angel Difference, Leading Wave 11.7 Lagging Wave 11.8 Impedance Function 12 Voltage and Current Relation in a 12.1 Pure Resistive Circuit 12.2 Pure Inductive Circuit 12.3 Pure Capacitive Circuit 12.4 Series RL Circuit 12.5 Series RC circuit 12.6 Series RLC Circuit 13 Effective Value of AC 14 Phasor Algebra 14.1 Impedance Complex Circuit 15. Conductance, Susceptance and Admittance of AC circuit 16. Power Factor Correction
Laboratory Equipment	For laboratory equipment (see ANNEX IV)

Course Name	**BASIC ELECTRONICS**
Course Description	This Course discusses the construction, operation and characteristics of basic electronics devices such as PN junction diode, light emitting diode, Zener diode, Bipolar Junction Transistor and Field Effect Transistor. Diode circuit applications such as clipper, clamper and switching diode circuits will be a part of the lecture. Operation of a DC regulated power supply as well as analysis of BJT and FET amplifier circuit will be tackled. This course also discusses the operation and characteristics of operational amplifiers
Number of Units for Lecture and Laboratory	Lecture - 2 units Laboratory – 1 unit
Number of Contact Hours per Week	Lecture - 2 hours Laboratory – 3 hours

Prerequisites	Basic Electrical Engineering
Course Objectives	After completing this course, the student must be able to: 1. Understand the basic operation, construction and characteristics of different electronic devices such as PN, junction diode, light emitting diode, Zener diode, Bipolar junction Transistor, Field Effect Transistor and Operational Amplifier as well as their application 2. Understand the operation of a DC regulated power supply. 3. Analyze BJT and FET amplifier circuits. 4. Analyze Operational amplifier circuits.
Course Outline	1. Introduction to Electronics Definition, History and application of Electronics Common Electronics Components 2. Solid State Fundamentals Conductor, Insulator, Semiconductor 3. Semiconductor PN Junction Diode 3.1 Construction and operation, characteristic curve 3.2 Diode Equivalent Model 3.3 Diode Circuit Analysis 3.4 Light Emitting Diode 4. DC Regulated Power Supply 4.1 Block Diagram, Transformer, Rectifier 4.2 Simple Capacitor Filter 4.3 Voltage Regulator 5. Bipolar Junction Transistor 5.1 Construction and schematic symbol 5.2 Region of Operation and characteristic curve of BJT Eber's Moll Model 5.3 Amplification factors and basic BJT Formula Switching Transistor Circuit 5.4 BJT amplifier Configuration 5.5 BJT amplifier Circuit analysis 5.6 FET Amplifier Regulation 5.7 JFET and MOSFET DC Analysis 5.8 FET AC small signal analysis 6. Operational Amplifiers 6.1 Block Diagram 6.2 Characteristics and Equivalent Circuit 6.3 Op-amp close loop operation
Laboratory Equipment	For laboratory equipment (see ANNEX IV)

Course Name	DC AND AC MACHINERY
Course Description	The course deals with performance characteristics and operation including losses and efficiencies of DC and AC machines such as alternators, induction/synchronous motors, synchronous converters and transformers. It includes demonstrations and laboratory experiments.
Number of Units for Lecture and Laboratory	Lecture –3 units Laboratory – 1 unit
Number of Contact Hours per Week	Lecture –3 hours Laboratory - 3 hours
Prerequisites	Basic Electrical Engineering
Course Objectives	After completing this course, the student must be able to: 1. Understand the characteristics of different types of DC Generators. 2. Know the effects of DC excitation upon the power delivered by an alternator 3. Know how to synchronize an alternator to the electric power utility system 4. Know the basic wiring connection of different types of Generators and alternators.
Course Outline	DC Generators, shunt and Compound Motors, single phase transformer, three-phase alternator Induction motors, synchronous motors
Laboratory Equipment	For laboratory equipment (see ANNEX IV)

E. FUNDAMENTAL MECHANICAL ENGINEERING COURSES

Course Name	**ORIENTATION TO ME**
Course Description	To provide information in the field of Mechanical Engineering
Number of Units for Lecture and Laboratory	Lecture -1 unit
Number of Contact Hours per Week	Lecture - 1 hour
Prerequisites	None
Course Objectives	After completing this course, the student must be able to familiarized themselves in the area of Mechanical Engineering dealing with different types of generating Power & Design of Machines
Course Outline	Career opportunities in taking-up Mechanical Engineering General Admission Requirements School Policies and Regulations. Textbooks & Syllabus Guidance and Counseling, Academic Activities
Laboratory Equipment	None

Course Name	**ADVANCED ENGINEERING MATHEMATICS FOR ME**
Course Description	A study of selected topics in mathematics and their applications in advanced courses in engineering and other allied sciences. It covers the study of Complex Numbers, Laplace and Inverse Laplace Transforms, Power series, Fourier series, Matrices and Determinants, Vector Analysis and Numerical Methods.
Number of Units for Lecture and Laboratory	Lecture – 3 units
Number of Contact Hours per week	Lecture – 3 hours
Prerequisite	Differential Equations
Course Objectives	After completing this course, the student must be able to: 4. Familiarize themselves with the different parameters, laws, theorems and the different methods of solutions in advance mathematics, 5. To develop their abilities on how to apply the different laws, methods and theorems particularly in complex problems.
Course Outline	1. Complex Numbers 2. Laplace and Inverse Laplace Transforms 3. Power Series 4. Fourier Series 5. Vector Analysis 6. Numerical Methods
Laboratory Equipment	NONE

Course Name	METHODS OF RESEARCH FOR MECHANICAL ENGINEERING
Course Description	This course covers the study of the methodologies used in conducting an engineering research. It includes the types and application of research, characteristics of a good research, research design, research instrument and data gathering procedures. It also deals with the study of writing a research proposal and various formats.
Number of Units for Lecture and Laboratory	Lecture- 1 units
Number of Contact Hours per week	Lecture - 1 hour
Prerequisite	English 3 (Technical Communication), Probability and Statistics
Course Objectives	After completing this course, the student must be able to: 4. Understand the research methods and procedures 5. Develop skills in writing a research proposal 6. Know to formulate a research problem 7. Prepare research proposal
Course Outline	1. Nature and characteristics of Research 2. Types of research 2.1 Basic 2.2 Applied 2.3 Pure 2.4 Characteristics of research 3. Research Problems and Objectives 3.1 Purpose of research 3.2 Developing research objectives 4. Review of Related Literature 4.1 Conceptual Literature 4.2 Research Literature 4.3 Referencing 5. Research Design 5.1 Experimental Design 5.2 Descriptive 6. Research Paradigm 6.1 Dependent Variable 6.2 Independent Variable 7. Data Processes and Statistical Treatment 7.1 T-test 7.2 Z-test 7.3 ANOVA 7.4 Regression 7.5 Hypothesis Testing 8. Writing Research Proposal 8.1 The Problem and Its Background a. Introduction b. Objectives c. Significance d. Scope and Delimitation 8.2 Review of Related Literature a. Conceptual b. Research 8.3 Research Methods and Procedure a. Research Design b. Data Gathering Procedure c. Research Instrument d. Sources of Information 9. Ethical Issues on Research
Laboratory Equipment	None

Course Name	**FLUID MECHANICS**
Course Description	The course deals with the nature and physical properties of fluids as well as the identification and measurement of fluid properties. It emphasizes the application of conservation laws on mass, energy and momentum to fluid systems either incompressible or compressible flow and inviscid or viscous flow as well as headloss calculation on pipes and fittings.
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture - 3 hours
Prerequisite	*Prerequisite:* Thermodynamics 1, *Co- requisite*: Dynamics of Rigid Bodies
Course Objectives	After completing this course, the student must be able to: 1. To understand the fundamental properties of fluid. 2. To introduce the integro-differential equation model of fluid flow using continuity equation, the momentum equation and the first law of thermodynamics 3. To understand the effects of viscosity in flow through pipes/tubes. To be proficient in the use of dimensional analysis in order to determine the relationship between bulk properties of fluids
Course Outline	**1. Introduction** **2. Properties of Fluids** Compressible and Incompressible Fluids, Differential and Integral form of the Fluid Dynamic Equation, Bulk Modulus of Elasticity, Gas Equation of State, Compressibility of Gases, Inviscid and Viscous Fluids, Surface Tension. **3. Fluid Statics** Pressure Variation in Static Fluid, Absolute and Gage Pressures, Pressure Measuring Devices, Force on Plane Area, Center of Pressure, Force on Curved Surface, Buoyancy and Stability of Submerged and Floating Bodies, Fluid Masses Subjected to Acceleration **4. Conservation of Energy** Equation of Steady Motion along a Streamline for an Ideal Fluid (Bernoulli's Equation) and Real Fluid, Energy Equation for Steady Flow of Incompressible Fluids, Power Considerations in Fluid Flow, Cavitation, Hydraulic Grade Line and Energy Line, Stagnation Pressure, Flow in a Curved Path, Forced Vortex, Free or Irrotational Vortex **5. Basic Hydrodynamics** Differential Equation of Continuity, Rotational and Irrotational Flow, Circulation and Vorticity, Stream Function, Velocity Potential, Orthogonality of Streamlines and Equipotential Lines **6. Similitude and Dimensional Analysis** Geometric Similarity, Kinematic Similarity, Dynamic Similarity, Scale Ratios, Dimensional Analysis and Buckingham II Theorem **7. Momentum and Forces in Fluid Flow** Impulse-Momentum Principle, Force Exerted on Pressure Conduits, Force Exerted on a Stationary Vane or Blade, Relation between Absolute and Relative Velocities, Force upon a Moving Vane or Blade, Torque in Rotating Machines and Head Equivalent of Mechanical Work, Momentum Principle applied to Propellers and Windmills **8. Steady Incompressible Flow in Pressure Conduits** Critical Reynolds Number, Hydraulic Radius, General Equation for Conduit Friction, Laminar Flow in Circular Pipes, Turbulent Flow, Pipe

	Roughness, Friction Factor, Fluid Friction in Noncircular Conduits, Different types of Losses, Branching Pipes, Pipes in Series and Parallel. **9. Fluid Measurements** Measuring Devices for Static Pressure and Velocity, Venturi Tube, Orifice Meter, Weirs 10. **Multi-Phase Flow**
Laboratory Equipment	None

Course Name	**MACHINE ELEMENTS 1 (Kinematics and Dynamics of Machines)**
Course Description	The course deals with the study of mechanisms disregarding the forces and energies that causes the motion. It emphasize on the analytical and graphical study of displacement, velocity and acceleration.
Number of Units for Lecture and Laboratory	Lecture - 2 units Laboratory - 1 unit (Computational Laboratory)
Number of Contact Hours per week	Lecture – 2 hrs Laboratory - 3 hours (Computational Laboratory)
Prerequisite	Dynamics of Rigid Bodies
Course Objectives	After completing this course, the student must be able to: 1. Understand the concepts of kinematics of machineries 2. Apply these concepts in the design of machine elements 3. Solve problems in kinematics of machineries using graphical and analytical methods
Course Outline	1. Introduction of the concepts of kinematics machineries 2. Vector operation in analytical and graphical method. 3. Motion and machinery: Displacement, velocity and acceleration, linkage and constraints. 4. Instant Center: Location of Instant Center 5. Velocity Analysis Method 6. Acceleration Analysis
Laboratory Equipment	Drafting Tables, computer (optional)

Course Name	**MACHINE ELEMENTS 2**
Course Description	A study of the elements of mechanism such as gears, train, rolling bodies, belt and pulleys, cams and follower
Number of Units for Lecture and Laboratory	Lecture -2 units Laboratory – 1 unit (Computational Laboratory)
Number of Contact Hours per week	Lecture - 2 hours Laboratory – 3 hours (Computational Laboratory)
Prerequisite	Machine Elements 1

Course Objectives	After completing this course, the student must be able to: 1. Understand the design concepts of different machine elements 2. Apply fundamental principles of Physics and Mathematics in the field of mechanical movement
Course Outline	1. Cam and Follower 2. Rolling Bodies in Pure Contact 3. Gears 4. Gear Train 5. Belts and Pulleys 6. Chains 7. Flexible Connections 8. Stepped Pulleys
Laboratory Equipment	Drafting Tables, computer (optional)

Course Name	**MATERIALS ENGINEERING**
Course Description	The course deals with the properties of engineering materials including mechanical acoustical, electrical, magnetic, chemical, optical and thermal properties; laboratory experiments using equipment include; tension, compression, bending shear, torsion and impact tests.
Number of Units for Lecture and Laboratory	Lecture - 3 units Laboratory - 1 unit
Number of Contact Hours per week	Lecture - 3 hrs Laboratory - 3 hrs
Prerequisite	General Chemistry, Mechanics of Deformable Bodies
Course Objectives	After completing this course, the student must be able to: 1. Understand the types, properties and characteristics of engineering materials 2. Identify the different new engineering materials and their industrial usage 3. Know the behavior of materials subject to different kinds of testing
Course Outline	1. Nature of materials 1.1 Types of Engineering Materials 1.2 Engineering Materials Composition 1.3 Chemical Bonding 2. Properties and characteristics of materials 2.1 Physical 2.2 Mechanical 2.3 Chemical 2.4 Thermal 2.5 Electrical 2.6 Magnetic 2.7 Optical 3. Material Testing 3.1 Tension Test 3.2 Compression Test 3.3 Coefficient of Thermal Expansion 3.4 Beam Deflection 3.5 Shear/ Torsion Test 4. Fracture Toughness and Fatigue and Engineering materials 4.1 Impact Testing

	4.2 Destructive Testing 4.3 Fatique Testing 5. Corrosion Prevention and Control 6.1 Significance and Purpose 6.2 Electrochemical nature of aqueous corrosion 6.3 Corrosion rate determinates 6.4 Galvanic and concentration cell corrosion 6. Non-Destructive Testing 6.1 Magnetic Particle 6.2 Ultrasonic Testing 6.3 Penetrant Testing 6.4 Radiographic Testing 7. Ferrous and Non – ferrous Metals 8. Ceramics 9. Polymers 10. Composite Materials 11. Nano and Bio Materials 12. Selection / Re – use and Recycling of Materials
Laboratory Equipment	Materials Engineering Laboratory Equipment (see Annex IV)

Course Name	**THERMODYNAMICS 1**
Course Description	A course dealing with the thermodynamic properties of pure substances, ideal and real gases and the study and application of the laws of thermodynamics in the analysis of processes and cycles. It includes introduction to vapor and gas cycles.
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture - 3 hours
Prerequisite	Integral Calculus, Physics 2
Course Objectives	After completing this course, the student must be able to know the principles underlying the utilization of energy in the thermal systems; open and closed systems; and introduction to gas and vapor cycles.
Course Outline	1. Introduction 2. Basic Principles, Concepts and definition 3. First Law of Thermodynamics 4. Ideal Gases/ Ideal Gas Laws 5. Processes of Ideal Gases 6. Properties of Pure Substance 7. Processes of Pure Substance 8. Introduction to cycle analysis: Second Law of Thermodynamics 9. Introduction to Gas and vapor cycles 10. Real Gases
Laboratory Equipment	None

Course Name	THERMODYNAMICS 2
Course Description	This course is aimed to further enhance the student's' knowledge regarding the principles of Thermodynamics by using these principles in practical application specifically in the field of power generation. This includes study of real gases, properties of gas and vapor mixtures and introduction to reactive systems.
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture -3 hours
Prerequisite	Thermodynamics 1
Course Objectives	After completing this course, the student must be able to: 1. To know the practical applications of the Thermodynamic principles learned in Thermodynamics 1. 2. To know the importance of two-phase vapor systems and its importance in relation to power production 3. To acquire the necessary knowledge with regards to gas power plants and standard air –power cycle
Course Outline	1. Review on the Thermodynamic Cycle 2. Simple Rankine Cycle Analysis 3. Improving Rankine Cycle Efficiency 4. Actual Rankine Cycle 5. Ideal and Actual Reheat Cycle 6. Ideal and Actual Regenerative Cycle 7. Ideal and Actual Reheat-Regenerative Cycle 8. Binary Cycles 9. Topping or superposing cycles 10. Incomplete Expansion Engine 11. Other Gas Power Cycles 11.1 Brayton Cycle 11.2 Air-standard cycle, OTTO/Diesel Cycle 12. Gas Compression Analysis 13. Real Gases 14. Properties of gas and vapor mixtures
Laboratory Equipment	None

Course Name	COMBUSTION ENGINEERING
Course Description	The course deals with principles involved in combustion, carburetion and fuel injection; fundamentals and basic principles of combustion processes, compression and combustion charts, fuels, (manifolds) engine components, engine performance and combustion engine design.
Number of Units for Lecture and Laboratory	Lecture - 2 units
Number of Contact Hours per week	Lecture - 2 hours
Prerequisite	Thermodynamics 2, Heat Transfer

Course Objectives	After completing this course, the student must be able to know the principles, operations, maintenance, design and selection of internal combustion engines.
Course Outline	1. Introduction 2. Principles of Thermodynamics 3. Mixture of Gases 4. Theoretical Cycles 5. Handling of Gaseous Fuels 6. Handling of Volatile Liquid Fuels 7. Handling of Fuel Oils 8. Engine Testing and Performance 9. Engine Design 10. External Combustion 11. Combustion of Fuels
Laboratory Equipment	None

Course Name	**HEAT TRANSFER**
Course Description	The course deals with the different modes of heat and mass transfer; laws governing conduction, convection and radiation and its application to the design of common heat exchangers such as condenser. Cooling coils and evaporators; and the environmental impact of their operation.
Number of Units for Lecture and Laboratory	Lecture – 2 units
Number of Contact Hours per week	Lecture - 2 hours
Prerequisite	Thermodynamics 1, Differential Equations, Fluid Mechanics
Course Objectives	After completing this course, the student must be able to: 1. Know the principles and different modes of heat transfer, their differences and applications. 2. Know the thermal conductivities and other relevant properties of the different materials and their applications in field of mechanical engineering. 3. Determine the heat transferred from one path to another and the temperature change at any point along the path. 4. Know the different types of heat exchangers and their applications. 5. Determine the proper size (length, radius, thickness, etc.) of tubes, no. of tubes and no. of passes necessary for a certain heat exchangers for particular application
Course Outline	1. Overview of heat transfer, modes of heat transfer, definitions, differences and applications. Thermal conductivities and other relevant properties of heat transfer materials (insulators, refractories, etc.). Modes of heat transfer applied in heat exchangers. 2. Conduction: Conduction rate equation. Steady-state conduction of plane wall (composite wall) and radial system 3. Conduction. Conduction with film coefficient of convection 4. Free Convection: Vertical Plates. Inclined and horizontal plates. Cylinders/ tubes , Spheres

	5. Forced convection: Pipe and tubes. Cylinders and spheres . Tube banks. 6. Radiation: Processes and properties 7. Radiation exchange between surfaces: The view factor. Blackbody radiation exchange. Radiation exchange between diffuse, gray surfaces 8. Multi-mode heat transfer: Combination of any two modes or all the modes of heat transfer 9. Heat exchangers: Types. Over-all heat transfer coefficient. Heat exchanger analysis. LMTD and AMTD. Parallel flow and Counter flow. Multi-pass and Cross flow. 10. Heat exchanger analysis. LMTD and AMTD. Parallel flow and Counter flow. Multi-pass and Cross flow
Laboratory Equipment	None

Course Name	**ME LABORATORY 1**
Course Description	The course involves the study and use of devices and instruments used to measure pressure, temperature level, flow, Speed, weight, area, volume, viscosity, steam quality, and products of combustion. It also includes the study and analysis of fuels and lubricants.
Number of Units for Lecture and Laboratory	Laboratory - 2 units
Number of Contact Hours per week	Laboratory - 6 hours
Prerequisite	Fluid Mechanics
Course Objectives	After completing this course, the student must be able to: 1. Understand engineering measurements and their application to engineering problems; involving theoretical and practical approach. 2. Analyze the significance of the quantities determined by the use of engineering measuring devices. 3. Know the basic concepts, uses and principles of engineering instruments and equipments. 4. Know the basic foundation for higher studies in mechanical engineering and a background on engineering materials, common engineering tools, mechanical engineering terms, devices and engine, and to involve students in identifying the different test method in determining the properties of fuels and lubricants. 5. Have the necessary training in the analysis of experimental data and results
Course Outline	Recommended Experiments: 1. Determination Of Density, Specific Gravity And Viscosity Of Liquid Fuels. 2. Flash And Fire Points of Liquid Fuels and Grease 3. Drop And Hardness Tests Of Greases 4. Carbon Residue Test 5. Test of Solid Fuel 6. Calorific Test Of Gaseous Fuel 7. Flue Gas Analysis

	8. Water And Sediments Test 9. Cloud And Pour Points Test 10. Distillation And Vapor Pressure Tests Of Gasoline Fuel 11. Calibration and use of Pressure And Temperature Measuring Instruments 12. Measurement Of Length, Areas, Speed and Time. 13. Calibration of Platform Scale 14. Calibration Of Volume Tank , Water Meter, Orifice, Venturimeter and Weir 15. Measurement Of Humidity 16. Determination Of Static, Velocity And Total Pressure Using Manometers And Pitot Tube 17. Dynamometer And Power Measurement.
Laboratory Equipment	Please See Annex IV

Course Name	**ME Laboratory 2**
Course Description	The course involves the study and test of mechanical engineering equipment and machineries such as steam generator, steam turbine, heat exchangers, internal and external combustion engines, pumps, fans, blowers and compressors
Number of Units for Lecture and Laboratory	Laboratory - 2 units
Number of Contact Hours per week	Laboratory -6 hours
Prerequisite	ME Laboratory 1 Heat Transfer
Course Objectives	After completing this course, the student must be able to: 1. Have a better understanding of the engineering measurements and their application to engineering problems; involving theoretical and practical approach. 2. Study and analyze the significance of the quantities determined by the use of engineering measuring devices. 3. Know the basic concepts, uses and principles of engineering instruments and equipment 4. Have a basic foundation for higher studies in mechanical engineering and a background on engineering materials, common engineering tools, mechanical engineering terms, devices and engine, and to involve students in identifying the different test method in determining the properties of fuels and lubricants. 5. Have the necessary training in the analysis of experimental data and results.
Course Outline	**Recommended experiments** 1. Physical study of the Steam Generating Unit 2. Test of Centrifugal Fan and Rotary Blower 3. Test of an Air Compressor 4. Measurement of a Steam Quality 5. Heat Loss Calculation through bare & lagged Pipes 6. Test of Parallel & Counter flow Heat Exchangers 7. Test of a Surface Condenser 8. Test of a Tubular Condenser 9. Visualization of Fluid Flow using Reynolds Number Apparatus

	10. Performance Test of an Internal Combustion Engine 11. Test of a Series and Parallel Pump Flow 12. Performance Test of a Positive Displacement Pump. 13. Performance Test of a Non-Positive Displacement Pump. 14. Performance Test of a Hydraulic Turbine
Laboratory Equipment	Please See Annex IV

Course Name	**INDUSTRIAL PROCESSES**
Course Description	A course dealing with the study of industrial and manufacturing processes and the equipment involved in the processes.
Number of Units for Lecture and Laboratory	Lecture -2 units
Number of Contact Hours per week	Lecture – 2hrs
Prerequisite	*Prerequisite:* ME Laboratory 2 *Corequisite:* Safety Engineering for ME
Course Objectives	After completing this course, the student must be able to: 1. Understand the different processes in industrial and manufacturing plants 2. Know the equipment utilized in the different industrial and manufacturing processes 3. Assess the safety and health practices in the different industrial and manufacturing plants.
Course Outline	1. Methods, processes and equipment involved in handling of solids a. Feeders and Storage silos b. Conveyors and Conveying systems c. Size reduction of solids d. Separation and classification of solids 2. Dryers and Drying Processes 3. Methods, processes and equipment involved in manufacturing: a. Cement b. Steel c. Glass d. Plastic and rubber e. Food and beverage f. Electronics and semi-conductors g. Metals 4. Packaging Processes and equipment
Laboratory Equipment	None

Course Name	SAFETY ENGINEERING FOR ME
Course Description	A course that deals with the study of industrial safety and health. It includes risk mitigation process and components from hazards and risk identification, evaluation and control.
Number of Units for Lecture and Laboratory	Lecture - 2 units
Number of Contact Hours per week	Lecture - 2 Hours
Prerequisite	*Prerequisite* :4th year standing , Safety Management *Co requisite* :Industrial Processes & Plant Visit/OJT
Course Objectives	After completing this course, the student must be able to: 1. Become aware of the health and safety concerns in an industrial setting and realize the importance of promoting safety and health as a professional and ethical responsibility. 2. Understand the basic concepts and processes of accident and incident causation, health and safety hazards and risk evaluation and mitigation processes. 3. Apply the concepts and principles of industrial safety and health to case studies and term projects.
Course Outline	1. Introduction to industrial safety and health 2. Safety and Health Management Practices 3. Accident Causation Theories and Concepts 4. Hazard Identification, Evaluation and Control 5. Incident/Accident Investigation and Causal factors analysis 6. Introduction to Behavior-Based Safety 7. Safety Management Systems 8. Job hazard analysis 9. Risk Assessment and Control 10. Industrial Hygiene 11. Case Studies
Laboratory Equipment	None

Course Name	WORKSHOP THEORY AND PRACTICE
Course Description	The course deals with the basic principles of machine shop practices. It includes workshop safety and organization; simple workshop measuring instruments, hand tools, fitting bench work, bench drill and bench grinder; sheet metal working; principles of welding processes; welding metallurgy; joining processes; testing and inspection of welds; foundry and metal casting.
Number of Units for Lecture and Laboratory	Laboratory - 2 units
Number of Contact Hours per week	Laboratory – 6 hrs
Prerequisite	Engineering Drawing

Course Objectives	After completing this course, the student must become familiar with the use of different tools applicable in basic cutting, joining and forming processes in machine shop practice.
Course Outline	1. Introduction to machine shop operations, layouts, tools and measuring instruments 2. Machines shop safety, rules and regulations 3. Metal working processes 4. Familiarization on the use of machine tools and equipment 4.1 Caliper 4.2 Ball Peen Hammer 4.3 Drilling and Grinding Machines 4.4 Lathe Machines 4.5 Shaper and Milling Machines 4.6 Welding Machines 4.7 Forge and Foundry equipment
Laboratory Equipment	Please see Annex IV

Course Name	**MACHINE SHOP THEORY**
Course Description	The course deals with use and operation of machines such as lathes, shapers, planers, drilling and boring machines, milling machine, cutters, grinding machines, machine tools and accessories. It covers technological advances in metal working and new innovations in machine shop.
Number of Units for Lecture and Laboratory	Laboratory - 2 units
Number of Contact Hours per week	Laboratory - 6 hrs
Prerequisite	Workshop Theory And Practice
Course Objectives	After completing this course, the student must be able to: 1. Acquire skills in the different machining operations 2. Understand the technological advances in the metal working industry.
Course Outline	1. Principles of Machine Shop Practices 2. Classification, Applications and Operations of Machines 3. New Technologies and Trends in Machine Shop Operations 4. Practical Exercises and Projects using the different types of machines 5. Introduction to numerical controlled machines and automation
Laboratory Equipment	Please see Annex IV

Course Name	**INSTRUMENTATION AND CONTROL ENGINEERING**
Course Description	The course introduces the basic concepts of instrumentation and process controls as well as important applications of feedback control systems with emphasis on analysis as well as design techniques.
Number of Units for Lecture and Laboratory	Lecture - 2 units Laboratory – 1 unit
Number of Contact Hours per Week	Lecture – 2 hours Laboratory – 3 hours
Pre – requisite	Basic Electronics Engineering

Course Objectives	After completing this course, the student must be able to: 1. Understand the basic concepts and operating principles of feedback control systems. 2. Understand the dynamic modeling of mechanical, electrical, electro – mechanical, fluid and thermodynamic System in relation to control. 3. Understand the dynamic response of control systems and its analysis. 4. Understand the concepts of proportional, derivative and integral (PID) control. 5. Understand the main features of digital control technology as compared to traditional continuous control systems
Course Outline	1. Overview and Brief History of Feedback control 2. Dynamic Modeling of Mechanical, Electrical, Electro – Mechanical 2.1 System Equations and Terminology 2.2 Review of Laplace Transforms 2.3 Transfer Functions 2.4 Block Diagrams and Signal Flow Graphs 3. Response of 1^{st}, 2^{nd} and higher – order Systems 4. Stability and Routh – Hourwitz Testing 5. Steady State Errors 5.1 Sensitivity and Disturbance Rejection 5.2 Performance Indices, Optimality and Design 6. Root Locus Construction and Examples 5.1 System Compensation 5.2 Design Using Root Locus Method 7. Bode Plot Construction 7.1 Frequency Response Examples 7.2 Gain and Phase Margins 7.3 Design Using Frequency Response 7.4 The Nyquist Criterion 8. Introduction to Digital Control System Design
Laboratory Equipment	Please see attached Annex IV

Course Name	**FLUID MACHINERY**
Course Description	The course is a comprehensive study of the principles and theories in the proper operation, selection and application of the most commonly used fluid machineries such as pumps, fans, blowers, compressors and turbines.
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture -3 hours
Prerequisite	Fluid Mechanics
Course Objectives	After completing this course, the student must be able to: 1. Understand the relationship between speed, quantity of fluid flow, head and power in fluid machinery. 2. Select appropriate fluid machineries in relation to industrial applications. 3. Understand the safe and proper operations of fluid machineries.
Course Outline	1. Definitions and terminologies 2. Dimensional Analysis as applied to fluid machineries 3. Specific Speed of fluid machineries 4. Basic pump construction (impellers, diffusers, etc.) 5. Net positive section head and cavitation 6. Pump operation, pipe sizing and selection

	7. Axial and Centrifugal pumps, fans and blowers 8. Basic turbine construction (blades, diffuser, etc.) 9. Impulse and reaction turbines 10. Sizing and selection of turbines 11. Applications of fluid machineries
Laboratory Equipment	None

Course Name	**REFRIGERATION SYSTEMS**
Course Description	The course is designed to provide a thorough foundation of the thermodynamic principles and components of mechanical refrigeration systems; cycles and associated equipment, and the effect of their operation on the environment.
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture -3 hours
Prerequisite	Thermodynamics 2, Heat Transfer
Course Objectives	After completing this course, the student must be able to: 1. Know the parts and functions of the components in a refrigeration system 2. Apply the basic heat and mass transfer principle in the analysis of refrigeration systems 3. Design a simple refrigeration system of a specified load and utilization
Course Outline	1. Introduction to refrigeration system. 2. Basic vapor compression refrigeration system 3. Refrigerants energy consumption and effects to environment. 4. Function and performance of the condenser and evaporator 5. Expansion devices 6. Physical and chemical properties of the different refrigerants 7. Multi-stage compression cycle. 8. Absorption refrigeration cycle 9. Air cycle refrigeration system 10. Steam jet refrigeration cycle 11. Introduction to cryogenics
Laboratory Equipment	None

Course Name	**AIR CONDITIONING AND VENTILATION SYSTEMS**
Course Description	AIR CONDITIONING THEORY AND DESIGN. The course deals with Psychrometric properties of air; factors affecting human comfort; air distribution and basic duct design, drying, heating and ventilation; cooling load calculations; complete design of an air-conditioning system and its components.
Number of Units for Lecture and Laboratory	Lecture -2 units Laboratory- 1 unit (computational laboratory)
Number of Contact Hours per week	Lecture - 2 hours Laboratory – 3 hours (computational laboratory)
Prerequisite	Refrigeration Systems

Course Objectives	After completing this course, the student must be able to: 1. Identify the components and functions of an air-conditioning system 2. Calculate the air conditioning load in a given application 3. Apply the principles of heat transfer and thermodynamic analysis to air-conditioning systems 4. Design a simple air-conditioning system for a given applications.
Course Outline	1. Air-conditioning system and its psychrometric processes and application 2. Cooling load calculations 3. Air distribution system, duct sizing and equipment specification 4. Refrigerant Piping, Chilled and Cooling Water Piping System, Air Conditioning Equipment Design and Selection, and Air Washers 5. Ventilation 6. Comfort condition and Indoor Air-Quality 7. Conventional and alternative air-conditioning systems
Laboratory Equipment	None

Course Name	**VIBRATION ENGINEERING**
Course Description	This course is intended to introduce the students to the fundamental concepts of vibration as it affects operation and performance of machine components. It involves modeling of mechanical systems, derivation of the differential equations for such systems and its varying solutions (responses) based on different excitations. Emphases will be on analysis, design, measurement, damping and computational aspects. The computer as a computational tool will also be utilized.
Number of Units for Lecture and Laboratory	Lecture -2 units
Number of Contact Hours per week	Lecture - 2 hours
Prerequisite	Differential Equations, Dynamics of Rigid Bodies
Course Objectives	After completing this course, the student must be able to: 1. Model a mechanical system in terms of its basic vibration elements. 2. Set up the differential equation with appropriate boundary / initial conditions corresponding to the mechanical system. 3. Evaluate the response for certain simple excitations. 4. Understand the concept and techniques of vibration measurement and control. 5. Use the computer for numerical analysis of vibration systems.
Course Outline	1. Basic Concepts of vibrating system 1.1 Equivalent solutions 1.2 Equivalent users 1.3 Equivalent damping 2. Free Vibration 2.1 Harmonic Motion 2.2 Viscous damping 2.3 Design Considerations 2.4 Stability 3. Harmonically Excitation Vibration 3.1 Equation of Motion

	3.2 Response of an Undamped System 3.3 Response of a Damped System 4. Vibration under General Forcing Conditions 4.1 Response under a general periodic force 4.4 Response under non-periodic force 5. Vibration Measurement 6. Vibration analysis & control
Laboratory Equipment	NONE

F. PROFESSIONAL MECHANICAL ENGINEERING COURSES

Course Name	**MACHINE DESIGN 1**
Course Description	The course deals with various mechanical properties of engineering materials in lieu of the determination of design factor and design stresses. It includes the analyses of simple, variable and combined stresses applied to different mechanical elements such as shafts, mechanical springs.
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture - 3 hrs
Prerequisite	*Prerequisite:* Machine Elements 2, Mechanics of Deformable Bodies *Corequisites:* Materials Engineering
Course Objectives	After completing this course, the student must be able to: 1. Understand the principles of designing machine elements 2. Acquire knowledge in the determination of design factor, design stresses, and the application of simple variable combined stresses to machine parts and elements. 3. Apply the principles in the design of simple mechanical components.
Course Outline	1. Analysis of Simple Stresses 1.1 Tensile 1.2 Compressive 1.3 shear or torsion 1.4 bending or flexural 2. Tolerance and Allowances 2.1 Tolerances 2.2 allowances 3. Variable Stress analysis 3.1 With stress concentration 3.2 Without stress concentration 3.3 Definite life design 3.4 Indefinite life design 4. Shaft design 4.1 Pure bending 4.2 Pure torsion 4.3 Combined loads(torsion: bending/ axial) 4.4 Shaft design using codes - PSME Code - ASME Code 5. Keys and coupling Design 5.1 Flat and square keys 5.2 Flexible coupling 6. Design of Screw fastening 6.1 types of bolts and screws 6.2 initial tension and tightening torque 6.3 Bolts and Screws in shear 7. Design of Mechanical Springs 7.1 coil and leaf springs elements 8. Design of Power Screws 8.1 Square thread 8.2 Acme thread 8.3 Buttress thread 9. Design of Machinery
Laboratory Equipment	None

Course Name	MACHINE DESIGN 2
Course Description	The course covers the design of various mechanical elements such as brakes and clutches, bearings, flexible transmitting elements, gears, flywheels. It also includes the study of welding design.
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture -3 hrs
Prerequisite	Machine Design 1
Course Objectives	After completing this course, the student must be able to: 1 Understand the principles of designing machine elements 2 Apply the principles in the design of complex machine elements.
Course Outline	1 Design of Flexible Transmission Elements 1.1 Belt Design a. V-belt b. Flat belt 1.2 Wire Ropes 1.3 Chain a. Roller b. Silent 2. Gear Design a. Spur gears b. Helical gears c. Bevel gear d. Worm gears 3. Flywheel Design 4. Brakes and Clutches 5. Bearings 5.1 Journal and Plane Surface Bearing 5.2 Roller Bearings 5.3 Lubrication 6. Welding Design 7. Design of Machineries
Laboratory Equipment	None

Course Name	ME LABORATORY 3
Course Description	The course deals with the performance analysis and evaluation of refrigeration, air-conditioning and ventilation systems and power plants.
Number of Units for Lecture and Laboratory	Laboratory - 2 unit
Number of Contact Hours per week	Laboratory – 6 hours
Prerequisite	ME Laboratory 2

Course Objectives	After completing this course, the student must be able to: 1. Design and conduct experiments involving performance test, heat balance and efficiency of various mechanical plants. 2. Prepare technical reports.
Course Outline	1. Performance, Heat Balance and Efficiency Test of a Simple Steam Power Plant 2. Performance, Heat Balance and Efficiency Test of a Diesel Electric Power Plant 3. Performance Test of a Mini – Hydroelectric Power Plant 4. Performance and Efficiency Test of a Refrigeration Plant 5. Performance test of a mini ice plant 6. Performance and Efficiency Test of an Air Conditioning Plant
Laboratory Equipment	Please see attached Annex IV
Suggested References	1997 ASHRAE Handbook of Fundamentals 1995 ASHRAE Handbook of HVAC applications 1996 ASHRAE Handbook of HVAC Systems and Air conditioning Systems Stoecker, W. and Jones, JW, *Refrigeration and Air Conditioning*, latest edition) *Arora, CP, Refrigeration and Airconditioning, McGraw-Hill, 2001* Power Plant Engineering by Frederick Morse, Quezon city, 1966 Power Plant Theory and Design by B.I. Potter, New York, 1959

Course Name	**INDUSTRIAL PLANT ENGINEERING**
Course Description	A study of mechanical engineering theories, equipment and systems that are needed in the operation of an industrial/manufacturing plant.
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture - 3 hours
Prerequisite	Industrial Processes, Plant Visits/OJT
Course Objectives	After completing this course, the student must be able to: 1. Understand and apply basic design concepts of industrial plants systems and equipment 2. Develop skills in selecting system components and equipment in industrial plant design. 3. Know the operations of industrial plants.
Course Outline	1. Basic design concepts of industrial plant systems and equipment 2. General piping systems and layouts of industrial plants 3. Principles of materials handling 4. Industrial Steam Processes 5. Industrial Waste Water treatment 6. Air pollution control systems for industrial application 7. Fire Protection System
Laboratory Equipment	None

Course Name	POWER PLANT ENGINEERING
Course Description	Study of the fundamental concepts in the design and installation of typical power plants such as steam power plant, diesel electric plant, geothermal power plant as well as other generating plants using non-conventional sources of energy.
Number of Units for Lecture and Laboratory	Lecture- 4 units; Laboratory-1 unit (computational laboratory)
Number of Contact Hours per week	Lecture- 4 hours; Laboratory- 3 hours (computational laboratory)
Prerequisite	Combustion Engineering, Fluid Machinery, Heat Transfer
Course Objectives	After completing this course, the student must be able to: 1. Acquire knowledge in the design and selection of equipment for power plants. 2. Apply technical knowledge in the design of simple power plants. 3. Prepare technical report which includes plans and specifications
Course Outline	1. Stationary power generating plant 2. Variable load problems. 3. Internal Combustion Engine (Diesel) Power Plant: 4. Cooling System 4.1 Types of cooling systems: Atmospheric cooling towers; mechanical draft; evaporative coolers 4.2 Cooling tower design and performance criteria evaluation 5. Steam Power Plant: 5.1 Boiler heat balance calculations; smoke stack/ chimney design 5.2 Forced draft and Induced draft fan design; Balanced draft 5.3 Steam Turbine; Types and classifications; construction; Performance and Design curves; Williams line; Turbine efficiencies and Turbine heat rates 6. Feedwater heaters: 7. Condensers and Evaporators: Types/ principle of operation/ design calculations and specifications 8. Gas Turbine Power Plants 9. Hydroelectric Power Plants 10. Geothermal Power Plants 11. Non-conventional Power Plants 12. Instrumentation and Controls 12.1 Overview of major control parameter in the power plant operation 12.2 Plant safety considerations 13. Power Plant Economics 13.1 Various cost components in power generation 13.2 Pie chart analysis & construction 13.3 Plant cost comparison of various types of power plants. 13. Co-generation and Energy Management System
Laboratory Equipment	None

Course Name	ME LAW, ETHICS, CODES AND STANDARDS
Course Description	The course deals with the study of the Mechanical Engineering law, code of ethics, ethical theories, and ethical issues in the practice of engineering. Familiarization with the technical codes and standards are included
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture- 3 hours
Prerequisite	Senior status, Orientation to ME
Course Objectives	After completing this course, the student must be able to: 1. Know the existing laws and ethical standards affecting the practice of the mechanical engineering profession. 2. Develop the skills of applying the codes to every mechanical engineering design. 3. Develop a sense of professional and ethical responsibility
Course Outline	1. The Mechanical Engineering Profession 2. The Mechanical Engineer in Society 3. Mechanical Engineering Law 4. The Mechanical Engineer's Code of Ethics 5. Ethical Theories (Duty ethics, Right ethics, Utilitarianism and Virtue Ethics) 6. Ethical Issues and case studies in Engineering 7. Local and International Codes and Standards 8. Contracts and Specifications
Laboratory Equipment	None

Course Name	PLANT VISIT OR OJT
Course Description	The study includes visits and/or exposure to power plants and industrial/manufacturing plants
Number of Units for Lecture and Laboratory	Laboratory – 2 units
Number of Contact Hours per week	Minimum of 120 hours for OJT or at least 8 companies for Plant Visit
Prerequisite	*Prerequisite:* Orientation to ME *Corequisite:* Safety Engineering for ME, Industrial Processes
Course Objectives	After completing this course, the student must be able to: 1. Understand actual mechanical engineering practice. 2. Gain actual experiences on various industrial processes and/or plant operations. 3. Learn both management and technical skills needed in the mechanical engineering profession. 4. Enhance personal traits and attain self-confidence.
Course Outline	*Suggested procedure in OJT Programs:* 1. Make a possible tie-up with companies 2. Select companies who can accept OJT students from the school. 3. Provide a "Memorandum of Understanding" with the company, which will admit students. 4. Forms can be made with regards to providing data of the prospective employer.

	5. Forms can be made in order to introduce the OJT program to the prospective employer. 6. Forms can be made regarding "Request for the OJT" to the prospective employer. 7. Furnish the prospective employer with the followings: a). Clearance to enroll in the OJT b). Attendance Report Form c). OJT Bio-Data Sheet d). Daily Attendance Record e). Evaluation Sheet for Actual Training 8. The faculty assigned should monitor the performance of the students 9. A final written report should be submitted by the student
Laboratory Equipment	None

Course Name	**ME PROJECT STUDY 1**
Course Description	The first phase of mechanical engineering project study involving writing and defense of the project proposal
Number of Units for Lecture and Laboratory	Laboratory – 1 unit
Number of Contact Hours per Week	Laboratory – 3 hours
Prerequisites	Methods of Research for ME
Course Objectives	After completing this course, the student must be able to: 1. Prepare and defend the project proposal. 2. Implement the first half of the approved project
Course Outline	N/A
Laboratory Equipment	Depending on the project

Course Name	**ME PROJECT STUDY 2**
Course Description	The second phase of the mechanical engineering project study which includes the completion and final defense of the approved project.
Number of Units for Lecture and Laboratory	Laboratory – 1 unit
Number of Contact Hours per Week	Laboratory – 3 hours
Prerequisites	ME Project Study 1
Course Objectives	After completing this course, the student must be able to: 1. Conduct scientific research project
Course Outline	N/A
Laboratory Equipment	Depending on the project

G. COURSE DESCRIPTION FOR SUGGESTED ELECTIVE COURSES

Mechatronics Engineering

1. Mechatronics - Introduction to mechanical system interfacing; combinational digital logic; industrial electronic components; industrial sensors; simple computer structure; low level programming techniques; embedded control computers; microcontroller; stepping motors; DC motors; analog/digital conversion; position and velocity measurement; amplifiers; projects related to mechatronics.

2. Introduction to Robotics - Rigid body motion, forward and inverse kinematics, manipulator Jacobians, force relation, dynamics and position control robot manipulators, force control and trajectory generation, collision avoidance and motion planning, robot programming languages.

3. Industrial Robot - Introduction Industrial Robots; robot reference frames; manipulator kinematics; inverse manipulator kinematics; Jacobian; manipulator dynamics; introduction to robot controls; trajectory generation; mechanism design; introduction to hybrid force/position control; summary.

4. Control Systems Engineering – Introduction to control system; mathematical models of systems; state-space description; dynamics simulation; feedback control system characteristics ; the performance of feedback control systems; the stability of linear feedback systems; essential principles of feedback, the root-locus method; frequency domain, time-domain analysis of control systems; the design and compensation of feedback control systems.

5. Digital Control - Introduction to discrete systems; time-domain representations of linear discrete systems; the analysis of discrete-time systems, z-transformation of linear discrete systems; state variable representation; analysis of linear discrete-time system: z-domain approach; the analytical design of discrete systems; engineering characteristics of computer control systems.

6. Industrial Automation & Control - Review of basic control system; industrial control component: pneumatic, electric, electronic and fluidic device; analysis and design of the complete control systems; special control applications: boiler control, air condition control, flight control, introduction to direct digital control and supervisory control.

Automotive Engineering

1. Automotive Engineering - Basic Principles; suspension system; body and chassis, brake system; steering system; front wheel geometry; transmission system, automotive equipment; performance factors.

2. Automotive Control – Basic electronics, principle of feedback control system; analog control system; digital control system; control device in automotive; sensors, controller, actuator; various control systems in automobile; system failure analysis.

3. Crankshaft and Dampers Design – Bearing loads – crankshaft mains and pins; stress analysis; engine and crankshaft balancing; inline 4 cylinder crankshaft design; vibration analysis; crankshaft stiffness, and torsional stress calculation, Carter's formula, Wilson's formula; crankshaft damper functions; crankshaft damper design.

4. Fundamental of Engine Block Design – Design concepts and block structure; material selection; cylinder head design parameters, factors affecting cylinder head design; dynamic behavior of cylinder blocks.

5. Power Train Noise Vibration and Harshness – Source and control of engine excitation; powertrain bending; engine accessory mounting considerations; driveline excitation; gear noise; transmission rollover noise and gear rattle, driveline transient resoponse; engine accessory noise; clutch related shudder.

6. Inherent Engine Unbalance – Fundamental of engine time varying force and moment; basic unbalance and coordinating systems; unbalance of single cylinder engine, bobweights consideration; multicylinder unbalance of single plane engines; multicylinder unbalance of V-type engine; valve-train unbalance; balance shaft.

7. Safety of Motor Vehicles – Mechanical characteristics of pneumatic tires; hydroplaning of pneumatic tires; force distribution during acceleration and braking; braking performance of vehicles; energy and performance; directional and stability control; rear end collision; elementary analysis of the two vehicle collision; crash protection and energy absorption.

8. Engine Crankcase Ventilation – Function and types of crankcase ventilation; limited blowby design considerations; engine purge; crankcase extraction; engine oil separator; air flow and vacuum control; provision for air distribution and vehicle dynamics; system maintenance; design parameters, blowby mapping, performance testing.

9. Engine Emissions and Control – Air pollution system, effects of pollutants; engine fundamentals, engine emissions; emission control techniques; instrumentation and techniques for measuring emissions.

10. Engine Fuel Control Systems - Fuel properties; fuel tank; carburetor; fuel injection system; injector; injection timing and control strategies; injector quality evaluation and testing; throttle body analysis and design; idle air control; fuel rail; fuel pumps and pressure regulator; fuel control systems for alternative fuels.

11. Catalytic Converters- Theory and Application – Fundamental pollution formation in IC engine; anatomy of a corverter; converter design for optimizing flow; chemical reactions; catalyst performance and application; catalyst deactivation and contamination; performance control and calibration.

12. Intake Manifold and Induction System Design – Engine intake manifold design, primary design parameters and tuning, analysis methods; multicylinder wave dynamics; flow losses in induction systems,; testing method for performance evaluation; noise in induction system, silencers.

13. Engine Friction and Lubrication – Fundamental of friction; wear; lubricants-engine oil; element of bearing lubrication and design; engine lubrication systems; bearing material, engine friction, engine friction modeling; surface and engine friction measurements.

14. Combustion Technology – Combustion phenomena; review of chemical kinetics, total collision frequency, equation of Arrhenius, activation energy, rates of reaction, ignition, quenching distance, flammability limits, fuel technology, stoichiometric combustion calculation, thermo-chemical analysis, theoretical flame temperature performance of steam boilers, boiler's efficiency boiler's heat balance sheet, boiler draught, fan power calculation, classification of industrial furnaces, heat source and heating method, operating method and material transfer equipment, furnace's radiative heat transfer, combustion apparatus, fuel-to-steam efficiency.

15. Tribology – Surface properties and measurement, contact of surfaces, friction theories, mechanism of wear, tribological properties of solid materials, friction instability, mechanics of rolling motion.

16. Aerodynamics - Basic relations describing flow field around wings and bodies at subsonic and super-sonic speed. Thin-wing theory. Slender-body theory. Formulation of theories for evaluating forces and moments on airplane geometries. Application to the design of high-speed airplanes.

Energy Engineering and Management

1. Alternative Energy Resource - Outlook for alternative energy resources, nuclear power production and utilization, technology of using coal and natural gas, biomass energy sources, biomass energy system, am introduction of solar energy thermal process, introduction of wind power equipment, thermal energy generation from geothermal energy and biogas energy systems.

2. Nuclear Energy Resources - A brief survey of energy demands and resources. Available nuclear energy, back-ground in atomic and nuclear physics; fission and fusion processes, physics of fission reactions- engineering aspects – safety and environmental effects, fusion-including laser fusion and magnetic confinement, and nuclear power economics.

3. Solar Energy and Wind Energy Utilization – Introduction to solar energy and its conversion for use on earth, fundamental of solar collection and thermal conversion, solar heating and cooling systems, wind energy, conversion system of wind energy to mechanical energy, sitting of wind machines and the design of wind power machines.

4. Energy Management in Buildings – Energy audit program for building and facilities, initiating energy management program, guidelines for methods of reducing energy usage in each area in buildings, conservation of the energy in the planning, design, installation, utilization, maintenance and modernization of the mechanical systems in the existing and new building, utilization of microcomputer in the energy management and in automatic controls of air conditioning and ventilation systems in building, and case study of energy saving in buildings.

5. Energy Management Industry - Energy balance studies for various equipment in industrial plants and options for improved efficiencies, waste heat recovery techniques, cogeneration concept in industry and management for efficient use of energy.

6. **Micro-hydro-electric Power Plant Design** - Design of a micro-hydro-electric power plant system and its components such as turbine, penstock, electro-mechanical control, etc.

7. **Management of Technology** – This course aims to present some of the important concepts and the diverse and interrelated issues in the management of technology. It will initially provide an overview by examining the link between technology on development and the process of technological change. It will then focus on the influence of technology on company level operations and to highlight the need for effective management of technology. Case studies will be used to further illustrate what has been covered in the lectures. Class participation is encouraged, and sharing of ideas and experiences will be facilitated.

Computers and Computational Science.

1. **Computer Aided Design and Manufacturing** - Introduction to CAD/CAM/CAE; product design and strategy; 3D modeling; surface design; computer aided manufacturing concept; the design and manufacturing interface; NC programming & verification; link to manufacture; CAD/CAM standard and data exchange; rapid-prototyping concept; total approach to product development.

2. **Finite Element Method** - Mathematical preliminaries and matrices, general procedure of the finite element method, derivation of finite element equations using; direct approach,

variational approach, and method of weighted residuals, finite element types in one, two, and three dimensions, and their interpolation functions, applications to structural, heat transfer, and fluid flow problems.

3. **Computational Fluid Mechanics** - Dynamics of body moving through a fluid medium; numerical solution of ordinary differential equations; inviscid fluid flows: panel singularities methods and numerical method for solving elliptic partial differential equations; viscous fluid flows: explicit and implicit methods for solving parabolic partial differential equations; secondary flows and flow instabilities: Galerkin method, upwind differencing and artificial viscosity.

Heating, Ventilating, Air-Conditioning and Refrigeration

1. **Conduction Heat Transfer** – Introduction; definition of concept and statement of general laws; formulation of heat conduction equations; lumped integral and differential formulation of general laws; initial and boundary conditions, solutions for steady and unsteady problems, one; two and three dimensional problems; method of solution, separation of variables, Laplace transform, partial solution, etc.

2. **Convention Heat Transfer** – Governing equations for heat and mass transfer, basic solutions for heat transfer in ducts and over external surfaces; heat and momentum transfer analogy, free convection; boiling and condensation.

3. **Radiation Heat Transfer** – Physics of radiation shapes factor; radiative exchange between surfaces; radiation through absorbing and transmitting media, radiation properties of gases; solar radiation.

4. **Advanced Refrigeration and Air-Conditioning** – Low temperature refrigeration, refrigeration system study, industrial applications of refrigeration, air conditioning system and building thermal environmental influences on air conditioning design, ventilation direct moist air and water, flow in ducts and a unconfined spaces, automatic control, testing, adjusting and balancing, economic factors in air-conditioning, noise and vibration control.

5. **Design of Thermal System** – Engineering design, design of a workable system, economics, equation fitting and mathematical modeling, system simulation, optimization, Lagrange multipliers, search methods, dynamic programming, linear programming.

6. **Indoor Air Quality in Buildings** - Indoor air pollutants in buildings and their transport dynamics with respect to building ventilation systems. Design methodology in handling indoor air quality in buildings and enclosed spaces. Building environmental assessment method.

7. **Ventilation and Air-Conditioning** – Psychrometric properties and process of air; criteria for thermal comfort; general ventilation; industrial ventilation; fume and dust removal; air conditioning load calculation; various types of air-conditioning system and equipment; air distribution and duct system design; air-conditioning piping design; noise and vibration control; air-conditioning control and instrumentation.

8. **Design of Building Piping Systems** – Cold and hot water supply for building, sizing of cold and hot water supply pipes; transfer pumps, booster pumps, pressure tanks, calculation and control; design and calculation and hot water generators; design and sizing of drainage and vent piping systems; design of the protection systems, namely, wet pipe indoor hydrant and sprinkler systems, halon gas systems; design and sizing of compressed air piping systems; energy conservation in plumbing system; sizing of boiler and steam pipes for hot water generation and other building uses; flexibility of piping system, expansion loop and expansion joint calculation and selection; design project.

9. **Noise and Vibration in Mechanical Services** - Fundamental concepts of sound and vibration; noise and people; room acoustics; sound insulation; vibration isolation; noise in ventilating system; noise control in practice; laboratory testing; case studies.

Manufacturing Engineering

1. **Tool and Die Design** – Principles and practice of tool design and tooling systems for a range of manufacturing processes and technologies; tooling requirements with due consideration of quality, time cost and quantity constraints, and within an overall manufacturing process plan.

2. **Jigs and Fixture Design** – Production tooling design, different types jigs and fixtures used in the manufacturing process. Design of jigs and fixtures that meet tooling requirements.

3. **Manufacturing Processes and System** – Introduction to the principles of manufacturing processes; process characteristics, capabilities and limitations; related machinery and equipment; automation and common aspects of manufacturing, including metrology and quality assurance.

4. **Materials Failure in Mechanical Applications** – Failure analysis, brittle and ductile fracture, creep rupture, fatigue cracking, environmental degradation of materials, damage tolerance design, life predication of engineering components, case studies.

5. **Introduction to Precision Engineering** – Principles of precision design, precision machining, and precision measurement; mathematical definitions and theoretical studies of tolerances for one-, two-, and three- dimensional precision assemblies; applications and industrial practices.

6. **Materials Characterization** – Study of microstructure, morphology, and chemical compositions of engineering materials using optical, x-ray and electron methods; specimen preparation, instrumentation and case studies.

Biomechanics

1. **Biomechanics of Human Movement and Control** – The Course is basically of mechanics concepts (statics and dynamics, kinematics and kinetics) to the study and analysis of human motion. It starts with the biological/ biomechanical foundation of human motion which includes the structure, functions, and the biomechanical properties of the bones, muscles, nerves, and other parts of the human body. The bulk of the course is concentrated on the use of kinematic analysis and kinetic analysis in the evaluation of human motion. It also includes an introduction to gait measurement and analysis.

2. **Orthopedics an Injury Mechanics** – This course provides a study of the biomechanics of musculoskeletal structure and musculoskeletal injury. The course explores the various cases of musculoskeletal injury to more fully understand causal mechanisms, the effects of injury on musculoskeletal tissues, and how current biomechanical and biomedical sciences contribute to injury management and prevention.

II. NON-TECHNICAL COURSES

A. SOCIAL SCIENCES (Please refer to CMO 59., s. 1996)
B. HUMANITIES (Please refer to CMO 59., s. 1996)

C. LANGUAGES (Please refer to CMO 59., s. 1996 for English 1 and 2)

Course Name	**ENGLISH 3 (TECHNICAL COMMUNICATION)**
Course Description	The nature of technical communication; skills and strategies for reading and writing literature reviews, journal articles, and technical reports; making oral presentations.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours lecture
Prerequisites	English 1, English 2
Course Objectives	After completing this course, the student must be able to: 1. Differentiate technical writing from other types of writing; 2. Engage him/herself critically in the reading of a specialized text; 3. Write a summary and review of a journal article; 4. Write a research paper on a technical topic; and 5. Properly acknowledge sources by using a prescribed citation format; 6. Prepare an oral presentation on a technical topic; and 7. Deliver properly an oral technical presentation.
Course Outline	1. The Nature of Technical Communication 2. Technical Writing 2.1. Introduction to Technical Writing 2.2. Library Orientation 2.3. Technical Writing: Formal Schema/Style; Word Choice 2.4. Types of Text Structure in Technical Writing 2.5. Introduction to Research: Choosing a Topic, Outlining 2.6. Skills and Strategies for Reading and Writing Journal Articles, Literature Reviews, and Technical Reports 2.7. Evaluating Sources and Preparing a Preliminary Bibliography 2.8. Preparing and Interpreting Non-Prose Forms 2.9. Summarizing and Analyzing a Journal Article 2.10. Preparing the Different Parts of the Research Paper or Technical Report 2.11. Writing Bibliographies Using a Prescribed Format 2.12. Independent Study 3. Oral Technical Presentations 3.1. Preparing the Presentation Materials 3.2. Delivering the Technical Presentation
Laboratory Equipment	None