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

CHED MEMORANDUM ORDER
No. 97
Series of 2017

SUBJECT: POLICIES, STANDARDS AND GUIDELINES FOR THE BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING (BSME) PROGRAM EFFECTIVE ACADEMIC YEAR 2018 - 2019

In accordance with the pertinent provisions of Republic Act (RA) No. 7722, otherwise known as the "*Higher Education Act of 1994*," in pursuance of an outcomes-based quality assurance system as advocated under CMO 46 s. 2012 (Policy-Standard to Enhance Quality Assurance in Philippine Higher Education through an Outcomes- Based and Typology – Based Quality Assurance), and as addendum to CMO 37, s. 2012 (Establishment of an Outcomes – Based Educational System in Higher Education Institutions Offering Engineering Programs), and by virtue of Commission en banc Resolution No. 788-2017 dated October 24, 2017 the following Policies, Standards and Guidelines (PSG) are hereby adopted and promulgated by the Commission.

ARTICLE I
INTRODUCTION

Section 1. Rationale

Based on the *Guidelines for the Implementation of CMO No. 46 series of 2012* and CMO 37 s. 2012, this PSG implements shift to outcomes based education leading to competency based standards. It specifies the 'core competencies' expected of BS in Mechanical Engineering graduates regardless of the type of Higher Education Institutions they graduate from. However, in recognition of outcomes-based education (OBE) and the typology of HEIs, this PSG also provides ample space for HEIs to innovate the curriculum in line with the assessment of how best to achieve learning outcomes in their particular contexts and their respective missions.

ARTICLE II
AUTHORITY TO OPERATE

Section 2. Government Recognition

All private higher education institutions (PHEIs) intending to offer BS in Mechanical Engineering must first secure proper authority from the Commission in accordance with this PSG. All PHEIs with an existing BSME program are required to shift to an outcomes-based approach based on CMO 37, s 2012 and guided by this PSG. State universities and colleges (SUCs), and local colleges and universities (LUC's) should likewise strictly adhere to the provisions of these policies and standards.

ARTICLE III
GENERAL PROVISIONS

Per Section 13 of RA 7722, the higher education institution shall exercise academic freedom in its curricular offerings but must comply with the minimum requirements for specific academic programs, the general education distribution requirements and the specific professional courses.

Section 3. Minimum Standards

The Articles that follow give minimum standards and other requirements and guidelines. The minimum standards are expressed as a minimum set of desired program outcomes which are given in Article IV Section 6. CHED designed a curriculum to attain such outcomes. This curriculum is shown in Article V Section 10 and Section 11 as sample curriculum. The number of units of this curriculum is here prescribed as the minimum unit requirement under Section 13 of RA 7722. To assure alignment of the curriculum with the program outcomes, this PSG provides a sample curriculum map in Article V Section 12 (details in Annex II) for the HEI to refer to in compliance with the implementing guidelines of CMO 37, s 2012.

Using a learner – centered / outcomes based approach, CHED provided a description of Outcomes Based Teaching and Learning delivery method in Article V Section 13. A sample course syllabus is also given in Article V Section 14 as support to the outcomes based delivery method. Based on the curriculum and the means of its delivery, CHED determined the physical resource requirements for the library, laboratories and other facilities and the human resource requirements in terms of administration and faculty. These are provided for in Article VI.

Section 4. Curriculum Design

The HEIs are allowed to design curricula suited to their own contexts and missions provided that they can demonstrate that the same leads to the attainment of the required minimum set of outcomes, albeit by a different route. In the same vein, they have latitude in terms of curriculum delivery and in terms of specification and deployment of human and physical resources as long as they can show that the attainment of the program outcomes and satisfaction of program educational objectives can be assured by the alternative means they propose.

The HEIs can use the **CHED Implementation Handbook for Outcomes-Based Education** *(OBE) and the Institutional Sustainability Assessment (ISA)* as a guide in making their submissions for Sections 19 to 24 of Article VII.

ARTICLE IV
PROGRAM SPECIFICATIONS

Section 5. Program Description

5.1 Degree Name:

The degree program described herein shall be called Bachelor of Science in Mechanical Engineering (BSME).

5.2 Nature of the Field of Study

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, mechanical engineers design space vehicles, computers, power plants, intelligent 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 mechanical engineering.

5.3 Program Educational Objectives

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve within a few years after graduation. PEOs are based on the needs of the program's constituencies and these shall be determined, articulated, and disseminated to the general public by the unit or department of the HEI offering the BSME program. The PEOs should also be reviewed periodically for continuing improvement

5.4 Specific Professions/careers/occupations for graduates

The scope of the practice of Mechanical Engineering is defined in the Mechanical Engineering Law of 1998 or R.A. 8495 and pertains to professional services to industrial plants in terms of: consultation requiring mechanical engineering knowledge, skill and proficiency; investigation; estimation and or valuation; planning, preparation of feasibility studies; designing; preparation of specifications; supervision of installation; operation including quality management; research, and among others. The teaching, lecturing and reviewing of a professional mechanical engineering subjects in the curriculum of the BSME degree or a subject in the Mechanical Engineering licensure examination given in any school, college, university or any other educational institution is also considered as practice of Mechanical Engineering.

5.5 Allied Fields

The following programs may be considered as allied to Mechanical Engineering: Electrical Engineering, Manufacturing Engineering, Aeronautical / Aerospace Engineering, Environmental Engineering, Energy Engineering, Biomedical Engineering, Materials Science and Engineering, Industrial Engineering, Mechatronics and Robotics Engineering, and Agricultural Engineering.

Section 6. Institutional and Program Outcomes

The minimum standards for the BS Mechanical Engineering program are expressed in the following *minimum* set of institutional and BSME program outcomes. The Program Outcomes also conform to the Level 6 Descriptors as specified in the Philippine Qualifications Framework (PQF).

6.1 Institutional outcomes

a) Graduates of professional institutions must demonstrate a service orientation in one's profession,
b) Graduates of colleges must participate in various types of employment, development activities, and public discourses, particularly in response to the needs of the communities one serves
c) Graduates of universities must participate in the generation of new knowledge or in research and development projects
d) Graduates of State Universities and Colleges must, in addition, have the competencies to support "national, regional and local development plans." (RA 7722).
e) Graduates of higher educational institutions must preserve and promote the Filipino historical and cultural heritage.

6.2. BSME Program Outcomes

By the time of graduation, the students of the program shall have the ability to:

a) apply knowledge of mathematics and science to solve complex mechanical engineering problems;
b) design and conduct experiments, as well as to analyze and interpret data;
c) design a system, component, or process to meet desired needs within realistic constraints, in accordance with standards;
d) function in multidisciplinary and multi-cultural teams;
e) identify, formulate, and solve complex mechanical engineering problems;
f) understand professional and ethical responsibility;
g) communicate effectively;

h) understand the impact of mechanical engineering solutions in a global, economic, environmental, and societal context
i) recognize the need for, and engage in life-long learning
j) know contemporary issues;
k) use techniques, skills, and modern engineering tools necessary for mechanical engineering practice;
l) know and understand engineering and management principles as a member and leader of a team, and to manage projects in a multidisciplinary environment;

A PHEI, SUC, or LUC, at its option, may adopt mission-related program outcomes that are not included in the minimum set

Annex I presents the Competency Standards, Attributes and competencies of a Mechanical Engineer which should result from the program outcomes stated above.

Section 7. Sample Performance Indicators

Performance Indicators are specific, measurable statements identifying the performance(s) required to meet the outcome; confirmable through evidence.

Table 1. Sample Performance Indicators of a Program Outcome

Program Outcomes		Performance Indicators	
a	Apply knowledge of mathematics and science to solve complex mechanical engineering problems	1	Apply concepts of advanced engineering mathematics to solve complex mechanical engineering problems
		2	Apply chemical and physical principles in solving problems involving energy and mass balance.
		3	Apply the laws of thermodynamics in analyzing problems
		4	Evaluate efficiencies of thermal and mechanical systems.

Section 8. Program Assessment and Evaluation

8.1 **Program Assessment** refers to one or more processes that identify, collect, and prepare data to evaluate the attainment of Program Outcomes and Program Educational Objectives.

8.2 **Program Evaluation** pertains to one or more processes for interpreting the data and evidence accumulated from the assessment. Evaluation determines the extent at which the Program Outcomes and the Program Educational Objectives are achieved by comparing actual achievement versus set targets and standards. Evaluation results in decisions and actions regarding the continuous improvement of the program.

All HEIs are encouraged to form a Consultative Body to be part of the assessment and evaluation processes to be represented by the stakeholders.

8.3 Assessment and Evaluation of PEOs

The Assessment of Program Educational Objectives may include the following: the stakeholders of the program have to be contacted through surveys or focus group discussion to obtain feedback data on the extent of the achievement of the PEOs.

8.4. Assessment and Evaluation of POs

In the case of Program Outcomes Assessment, the defined Performance Indicators shall be connected to Key Courses (usually the Demonstrating or "D" courses in the Curriculum map), and an appropriate Assessment Methods (AM) may be applied. These methods may be direct or indirect depending on whether the demonstration of learning was measured by actual observation and authentic work of the student or through gathered opinions from the student or his peers. Refer to Table 2.

Table 2. Sample Matrix Linking Performance Indicators with Key Courses and Assessment Methods

Performance Indicators		Key Courses	Assessment Methods
1	Apply concepts of advanced engineering mathematics to solve complex mechanical engineering problems	Industrial Plant Design	Design Project
2	Apply chemical and physical principles in solving problems involving energy and mass balance.	Power Plant Engineering	Technical Report
3	Apply the laws of thermodynamics in analyzing problems	Air - Conditioning and Ventilation Systems	Final Examination
4	Evaluate efficiencies of thermal and mechanical systems.	Fluid Machineries	Final Examination

Table 3. Sample Matrix Linking Assessment Methods with Targets and Standards

Key Courses	Assessment Methods	Targets and Standards
Industrial Plant Design	Design Project	70% of students get a satisfactory rating
Power Plant Engineering	Technical Report	70% of students get a satisfactory rating
Air conditioning and Ventilation Systems	Final Examination	60% of students get a satisfactory rating
Fluid Machineries	Final Examination	60% students get a satisfactory rating

**Note:* The values on the Target and Standards are just examples.

Other Methods of Program Assessment and Evaluation may be found in the CHED Implementation Handbook for Outcomes-Based Education (OBE) and Institutional Sustainability Assessment (ISA).

Section 9. Continuous Quality Improvement

There shall be a documented process for the assessment and evaluation of program educational objectives and program outcomes.

The comparison of achieved performance indicators with declared targets or standards of performance should serve as basis for the priority projects or programs for improving the weak performance indicators. Such projects and programs shall be documented as well as the results of its implementation. This regular cycle of documentation of projects, programs for remediation and their successful implementation shall serve as the evidence for Continuous Quality Improvement (CQI).

ARTICLE V
CURRICULUM

Section 10. Curriculum Description

The BS Mechanical Engineering curriculum has a total of 172 credit units. The program comprised of the general education, technical, allied, fundamental, professional, and technical elective courses. Thesis projects are optional, however, the courses M.E Project Study 1 and M.E. Project Study 2 may be utilized for a thesis course. For the capstone design project which gives the students a culminating design experience, the school may choose either Power Plant Design or Industrial Plant Design. The HEIs have the option to offer either Plant Visits or On-the-Job Training. On – the – job training shall have a minimum of 240 hours. The general education courses are in accordance with the requirements of the CMO No. 20, s. 2013- General Education Curriculum: Holistic

Understandings, Intellectual and Civic Competencies. The technical courses comprised of the 12 units of Mathematics, 8 units of Physical/Natural Sciences, 19 units of Basic Engineering Sciences, 9 units of allied courses, 50 units of fundamental courses, 20 units of professional courses and 6 units of technical elective courses. The non-technical courses comprised of 36 units of General Education and elective courses and 14 units of PE/NSTP.

Section 11. Sample Curriculum

11.1 Components

Classification/ Field / Course	Minimum Hours/week		Minimum Credit Units
	Lecture	Laboratory	
I. TECHNICAL COURSES			
A. Mathematics			
Calculus 1	3	0	3
Calculus 2	3	0	3
Differential Equations	3	0	3
Engineering Data Analysis	3	0	3
Sub-Total	**12**	**0**	**12**
B. Natural/Physical Sciences			
Chemistry for Engineers	3	3	4
Physics for Engineers	3	3	4
Sub-Total:	**6**	**6**	**8**
C. Basic Engineering Sciences			
Engineering Drawing	0	3	1
Computer – Aided Drafting	0	3	1
Computer Fundamentals & Programming	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 Economics	3	0	3
Engineering Management	2	0	2
Technopreneurship 101	3	0	3
Sub-Total:	**16**	**9**	19

Classification/ Field / Course	Minimum Hours/week		Minimum Credit Units
	Lecture	Laboratory	
D. Allied Courses			
Basic Electrical Engineering	2	3	3
Basic Electronics	2	3	3
DC and AC Machinery	2	3	3
Sub-Total:	**6**	**9**	**9**
E. Fundamental Mechanical Engineering Courses			
Mechanical Engineering Orientation	1	0	1
Advanced Mathematics for ME	3	0	3
Methods of Research for ME	1	0	1
Fluid Mechanics	3	0	3
Machine Elements	2	3	3
Materials Science and Engineering for ME	2	3	3
Thermodynamics 1	3	0	3
Thermodynamics 2	3	0	3
Combustion Engineering	2	0	2
Heat Transfer	2	0	2
ME Laboratory 1	0	3	1
ME Laboratory 2	0	6	2
Manufacturing and Industrial Processes with Plant Visits*	1	3*	2
Basic Occupational Safety and Health	3	0	3
Workshop Theory and Practice	0	3	1
Machine Shop Theory	0	6	2
Control Engineering	2	3	3
Fluid Machineries	3	0	3
Refrigeration Systems	3	0	3

Classification/ Field / Course	Minimum Hours/week		Minimum Credit Units
	Lecture	Laboratory	
Air-conditioning and Ventilation Systems	3	0	3
Vibration Engineering	2	0	2
Computer Applications for ME	0	3	1
Sub-Total:	**39**	**33**	**50**
F. Professional Mechanical Engineering Courses			
Machine Design 1	3	0	3
Machine Design 2	2	3	3
ME Laboratory 3	0	6	2
Industrial Plant Engineering	3	3	4
Power Plant Design with Renewable Energy	3	3	4
ME Laws, Ethics, Codes and Standards	2	0	2
ME Project Study 1	0	3	1
ME Project Study 2	0	3	1
Sub-Total:	**13**	**21**	**20**
G. Electives Courses			
ME Electives	4	0	4
Sub-Total:	**4**	**0**	**4**
TOTAL TECHNICAL COURSES	**96**	**78**	**122**
II. NON TECHNICAL COURSES			
A. General Education Courses			
Purposive Communication	3	0	3
Mathematics in the Modern World	3	0	3
Understanding the Self	3	0	3
Art Appreciation	3	0	3

Classification/ Field / Course	Minimum Hours/week		Minimum Credit Units
	Lecture	Laboratory	
Ethics	3	0	3
Readings in Philippine History	3	0	3
The Contemporary World	3	0	3
Science, Technology and Society	3	0	3
Sub-Total:	**24**	**0**	**24**
B. General Education Elective AND Mandated Courses			
G.E. Elective 1	3	0	3
G.E. Elective 2	3	0	3
G. E. Elective 3	3	0	3
Life and Works of Rizal	3	0	3
Sub-Total:	**12**	**0**	**12**
C Physical Education			
P.E. 1, 2,3,4 (2 units each)			8
Sub-Total:			**8**
D. National Service Training Program			
NSTP 1 & 2			6
Sub-Total:			**6**
TOTAL NON-TECHNICAL COURSES	**36**	**0**	**50**
GRAND TOTAL			**172**

*OJT may be substituted for Plant Visits

Suggested Elective Courses:

A. Mechatronics Engineering 1. Mechatronics 2. Introduction to Robotics 3. Industrial Robots
B. Automotive Engineering 1. Automotive Control 2. Safety of Motor Vehicles 3. Engine Fuel Control Systems 4. Engine Emission and Control 5. Engine Friction and Lubrication
C. Energy Engineering and Management 1. Nuclear Energy 2. Solar Energy and Wind Energy Utilization 3. Micro-hydro-electric power 4. Energy Management in Buildings
D. Computers and Computational Science 1. Computer - Aided Design and Manufacturing 2. Finite Element Method 3. Computational Fluid Dynamics
F. Heating, Ventilating, Air-Conditioning and Refrigeration 1. Design of Thermal Systems 2. Indoor Environmental Quality in Buildings 3. Design of Building Piping System and Air-conditioning Ductworks

SUMMARY OF THE BSME CURRICULUM

Classification/ Field	Total No. of Hours		Total No. of Units
	Lecture	Laboratory	
I. TECHNICAL COURSES			
A. Mathematics	12	0	12
B. Natural/Physical Sciences	6	6	8
C. Basic Engineering Sciences	16	9	19
D. Allied Courses	6	9	9
E. Fundamental Courses	39	33	50
E. Professional Courses	13	21	20
F. Technical Electives	4	0	4
TOTAL (TECHNICAL COURSES)	**96**	**78**	**122**
II. NON TECHNICAL COURSES			
A. General Education Courses	24	0	24
B. General Education Elective Courses/ Mandated Courses	12	0	12
C. PE and NSTP			14
TOTAL (NON-TECHNICAL COURSES)	**36**	**0**	**50**
GRAND TOTAL	**132**	**92**	**172**

11.2. 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 and co-requisites are complied with.

The sample Program of Study provided in this PSG is meant for HEIs operating on a semestral system. HEIs with CHED approved trimester or quarter term systems may adjust their courses and course specifications accordingly to fit their delivery system, as long as the minimum requirements are still satisfied.

The HEIs are also encouraged to include other courses to fulfill their institutional outcomes, as long as the total units for the whole program shall not be less than **172 units**, including P.E., and NSTP.

SAMPLE SEMESTRAL PROGRAM OF STUDY

FIRST YEAR

1st Year – First Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
National Service Training Program 1	0	3	3	
Physical Education 1	0	2	2	
Purposive Communication	3	0	3	
Mathematics in the Modern World	3	0	3	
Understanding the Self	3	0	3	
Calculus 1	3	0	3	
Chemistry for Engineers (lec)	3	0	3	
Chemistry for Engineers (lab)	0	3	1	Chemistry for Engineers lec. (C)
Engineering Drawing	0	3	1	
Mechanical Engineering Orientation	1	0	1	
TOTAL	**16**	**11**	**23**	

1st Year – Second Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
National Service Training Program 2	0	3	3	National Service Training Program 1
Physical Education 2	0	2	2	
Art Appreciation	3	0	3	
Life and Works of Rizal	3	0	3	
Readings in Philippine History	3	0	3	
Calculus 2	3	0	3	Calculus 1
Physics for Engineers	3	3	4	Calculus 1 / Co-requisite of Calculus 2
Computer – Aided Drafting	0	3	1	Engineering Drawing
The Contemporary World	3	0	3	
TOTAL	**18**	**11**	**25**	

SECOND YEAR

2nd Year – First Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Physical Education 3	0	2	2	
Science, Technology and Society	3	0	3	
Differential Equations	3	0	3	Calculus 2
Statics of Rigid Bodies	3	0	3	Physics for Engineers / Calculus 2
Basic Electrical Engineering	2	3	3	Physics for Engineers / Calculus 2
Computer Fundamentals and Programming	0	3	1	
Thermodynamics 1	3	0	3	Physics for Engineers / Calculus 2
Workshop Theory and Practice	0	3	1	
G.E. Elective 1	3	0	3	Chemistry for Engineers
TOTAL	**17**	**11**	**22**	

2nd Year – Second Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Physical Education 4	0	2	2	
Engineering Data Analysis	3	0	3	Calculus 1
Dynamics of Rigid Bodies	2	0	2	Statics of Rigid Bodies
Basic Electronics	2	3	3	Basic Electrical Engineering
Thermodynamics 2	3	0	3	Thermodynamics 1
Machine Shop Theory	0	6	2	Workshop Theory and Practice
Engineering Management	2	0	2	
Advanced Mathematics for ME	3	0	3	Differential Equations
TOTAL	**15**	**11**	**20**	

THIRD YEAR

3rd Year – First Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Mechanics of Deformable Bodies	3	0	3	Dynamics of Rigid Bodies (S)
Engineering Economics	3	0	3	
DC and AC Machinery	2	3	3	Basic Electrical Engineering
Heat Transfer	2	0	2	Thermodynamics 2
Fluid Mechanics	3	0	3	Thermodynamics 1
Machine Elements	2	3	3	Dynamics of Rigid Bodies
Vibration Engineering	2	0	2	Differential Equations
Computer Applications for ME	0	3	1	Computer Fundamentals & Programming
TOTAL	**17**	**9**	**20**	

3rd Year – Second Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Methods of Research for M.E.	1	0	1	Engineering Data Analysis
Refrigeration Systems	3	0	3	Heat Transfer
Fluid Machineries	3	0	3	Fluid Mechanics
Combustion Engineering	2	0	2	Thermodynamics 2
Materials Science & Engineering for ME	2	3	3	Mechanics of Deformable Bodies / Chemistry for Engineers
Mechanical Engineering Lab 1	0	3	1	Thermodynamics 2
Ethics	3	0	3	
G.E. Elective 2	3	0	3	
Mechanical Engineering Elective 1	2	0	2	
TOTAL	**19**	**6**	**21**	

FOURTH YEAR

4th Year – First Semester

Description of Subjects	No. of hours		Units	Prerequisites/*Corequisite*
	Lecture	Laboratory		
Mechanical Engineering Elective 2	2	0	2	
ME Project Study 1	0	3	1	Methods of Research for ME
Air-conditioning and Ventilation Systems	3	0	3	Refrigeration Systems
Control Engineering	2	0	2	Basic Electronics
Control Engineering Laboratory	0	3	1	Control Engineering (C)
Power Plant Design with Renewable Energy	3	3	4	Combustion Engineering
Machine Design 1	3	0	3	Machine Elements
Technopreneurship	3	0	3	
Mechanical Engineering Lab 2	0	6	2	Fluid Machineries, M.E. Lab 1
TOTAL	**16**	**15**	**21**	

4th Year – Second Semester

Description of Subjects	No. of hours		Units	Prerequisites
	Lecture	Laboratory		
Industrial Plant Engineering	3	3	4	Air-conditioning and Ventilation Systems, Manufacturing and Industrial Plant Visits (C)
ME Project Study 2	0	3	1	ME Project Study 1
Machine Design 2	2	3	3	Machine Design 1
Basic Occupational Safety and Health	3	0	3	
Manufacturing & Industrial Processes with Plant Visits	1	3	2	
Mechanical Engineering Lab 3	0	6	2	Power Plant Design with Renewable Energy
ME Laws, Ethics, Contracts, Codes & Standards	2	0	2	Ethics
G.E. Elective 3	3	0	3	
TOTAL	**14**	**18**	**20**	

Section 12. Sample Curriculum Map

Refer to **Annex II** for the Minimum Program Outcomes and Curriculum Map Template. The HEIs may develop their own Curriculum Map.

Section 13. Description of Outcomes - Based Teaching and Learning

Outcomes-based teaching and learning (OBTL) is an approach where teaching and learning activities are developed to support the learning outcomes. It is a student-centered approach for the delivery of educational programs where the curriculum topics in a program and the courses contained in it are expressed as the intended outcomes for students to learn. It is an approach in which teachers facilitate and students find themselves actively engaged in their learning.

Its primary focus is the clear statement of what students should be able to do after taking a course, known as the Intended Learning Outcomes (ILOs). The ILOs describe what the learners will be able to do when they have completed their course or program. These are statements, written from the students' perspective, indicating the level of understanding and performance they are expected to achieve as a result of engaging in teaching and learning experience. Once the ILOs have been determined, the next step in OBTL is to design the Teaching / Learning Activities (TLAs) which require students to actively participate in the construction of their new knowledge and abilities. A TLA is any activity which stimulates, encourages or facilitates learning of one or more intended learning outcome. The final OBTL component is the Assessment Tasks (ATs), which measure how well students can use their new abilities to solve real-world problems, design, demonstrate creativity, and communicate effectively, among others. An AT can be any method of assessing how well a set of ILO has been achieved.

A key component of a course design using OBTL is the constructive alignment of ILOs, TLAs, and ATs. This design methodology requires the Intended Learning Outcomes to be developed first, and then the Teaching / Learning Activities and Assessment Tasks are developed based on the ILOs.

"Constructive" refers to the idea that students construct meaning through relevant learning activities; "alignment" refers to the situation when teaching and learning activities, and assessment tasks, are aligned to the Intended Learning Outcomes by using the verbs stipulated in the ILOs. Constructive alignment provides the "how-to" by stating that the TLAs and the assessment tasks activate the same verbs as in the ILOs.
The OBTL approach shall be reflected in the Course Syllabus to be implemented by the faculty.

Section 14. Course Syllabus and Course Specifications

The Course Syllabus must contain at least the following components:

14.1. General Course Information (Title, Description, Code, Credit Units, Prerequisites)
14.2 Links to Program Outcomes
14.3 Course Outcomes
14.4 Course Outline (Including Unit Outcomes)
14.5 Teaching and Learning Activities
14.6 Assessment Methods
14.7 Final Grade Evaluation
14.8 Learning Resources
14.9 Course Policies and Standards
14.10 Effectivity and Revision Information

Refer to **Annex III** for Sample Course Specifications for the courses listed in the Sample Curriculum Map and **Annex V** for sample course syllabus.

ARTICLE VI
REQUIRED RESOURCES

This article covers the specific required resources for the BS Mechanical Engineering program.

All other requirements on Administration, Library and Laboratory facilities, and buildings for the BS Engineering Program are contained in CMO No. 86, s. 2017, Policies, Standards and Guidelines for Requirements Common to all BS Engineering and Bachelor of Engineering Technology Programs issued by the Commission.

Section 15. Administration

The administration of the college of engineering must provide academic governance and leadership to engineering programs by exerting efforts to achieve program educational objectives and program outcomes. As such, the college must have a full-time dean and full-time department or program chair who are adept in the principles of outcomes-based education and are trained to implement the elements of OBE and OBTL required by CMO 37 s2012.

There shall be a full-time Department / Program Chair / Coordinator who will lead in the curriculum planning, implementation, monitoring, review, and evaluation of the B.S. Mechanical Engineering program. The college dean may serve as concurrent department or Program Chair when appropriate.

The B.S. Mechanical Engineering Department under the College of Engineering shall be administered by a Department or Program Chair who shall have the following qualifications:
a) Holder of a B.S. Mechanical Engineering degree;
b) Holder of Master's degree in Mechanical Engineering or related fields in accordance with CMO 50 s 2006 (Recognition of Specialized Allied and Related Post Graduate Degrees as Qualification for Teaching Professional Mechanical Engineering Courses).
c) Registered Mechanical Engineer with valid PRC ID; and
d) Has at least three (3) years of teaching experience.

Section 16. Faculty

16.1 Requirements

There must be an adequate number of competent and qualified faculty to teach all of the curricular areas of the Mechanical Engineering program and appropriate student-faculty ratio to effectively implement the minimum requirements set by CHED and the Professional Regulation Commission.

The faculty member teaching professional Mechanical Engineering courses should be a Professional Mechanical Engineer (PME) or a Registered Mechanical Engineer (RME) with master's degree in Mechanical Engineering or related fields in accordance with CMO 50 s 2006 (Recognition of Specialized Allied and Related Post Graduate Degrees as Qualification for Teaching Professional Mechanical Engineering Courses).

16.2 Duties

The faculty shall be actively involved in the following areas of implementation of BSME program:

a. curriculum review, decision-making, and implementation of the academic program

b. program assessment and evaluation, and implementation of continuous improvement of the program
c. development, improvement, and achievement of course outcomes (COs)
d. enrichment of teaching/learning activities(TLAs)
e. development and improvement of assessment tasks, constructively aligned with COs and TLAs
f. student advising activities of the program
g. research and scholarly work
h. professional services offered by the program
i. linkage and extension work

Section 17. Library and Other Learning Resources

The library services and other learning resources are covered in Section 2.3 of CMO No. 86, s. 2017.

Section 18. Laboratory Equipment and Resources

18.1 Facilities

Facilities are covered in Section 2.4,5.4 of CMO No. 86, s. 2017.

18.2 Laboratories for the Mechanical Engineering Program

The program shall provide laboratories/fieldwork/drafting facilities for the following courses:

1. Chemistry for Engineers
2. Physics for Engineers
3. Engineering Drawing
4. Machine Elements
5. ME Laboratories 1, 2 and 3
6. Workshop Theory and Practice
7. Machine Shop Theory and Practice
8. Control Engineering
9. Machine Design
10. Power Plant Design
11. Industrial Plant Engineering

Table – type laboratory equipment and set – up are acceptable. To familiarize students with the actual equipment, it is suggested that a field inspection trip be conducted.

The program shall provide adequate computing facilities for courses in Computer Fundamentals and Programming, Computer-Aided Drafting, Computer Applications for ME.

Refer to **Annex IV** for the Laboratory equipment and resources required for the program, The institution must provide access to modern tools in ME. Examples of these tools are spreadsheet software, graphing software, mathematical software, programming language environment, open or commercial simulation tools in ME, and design and analysis software. These modern tools shall be sufficient so that students can achieve the course outcomes.

Each ME Department of the college of engineering shall have a program for the continuing modernization and upgrading of its instructional laboratories, facilities, and equipment. The said program shall have an adequate annual allocation in accordance with the financial capability of the school.

18.2.1 Calibration of Equipment

Each school/college of engineering shall ensure that the measuring instruments in its laboratories are recalibrated regularly. The date of the last calibration of a measuring instrument shall be indicated on each instrument.

ARTICLE VII
COMPLIANCE OF HEIs

Section 19. Full Compliance with CMO 37, s. 2012

Before the start of AY 2018-2019, all HEIs offering BSME program must show evidence of full compliance with CMO 37, s. 2012 (Establishment of an Outcomes-Based Education System) by the following actions:

19.1 CMO 37 Monitoring Workbook and Self-Assessment Rubric

The Commission, through its Regional offices or the TPET Website shall make available to all HEIs currently offering or applying to offer BS Mechanical Engineering programs a Monitoring Workbook (CMO 37-MW-2017-HEI-BSME) and Self-Assessment Rubric (SAR) (CMO-37-HEI-SAR-2017-BSME).

The five-year BSME Curriculum shall be the basis of the monitoring. The completed Monitoring Workbook with a List of Supporting Evidences and Self-Assessment Rubric must be submitted to CHED or online through the CHED TPET website (www.ched-tpet.org) within 30 working days after the effectivity of this CMO. Failure to submit these documents will disqualify the concerned HEIs to continue or start their BSME programs in AY 2018-2019.

19.2 Review of Submitted Forms by CHED

CHED shall review the submitted Monitoring Workbooks and Self-Assessment Rubrics, and may schedule monitoring visits to the HEI thereafter. These visits shall determine the extent of compliance of the concerned HEI with CMO 37, s. 2012. HEIs with BSME programs with low SAR total scores may be asked to submit a one- or two-year development plan to CHED before they shall be allowed to apply to continue their BSME program for AY 2018-2019.

19.3 Exemptions

HEIs with BSME that have applied as COEs/CODs during AY 2015-2016 and whose applications have been approved as COE or COD shall not be required to comply with Section 19.1 and 19.2. Instead, these HEIs must submit only their proposed four-year curriculum, corresponding curriculum map, and program of study using the Application Workbook for AY 2018-2019 (AW-2018-HEI-BSME). See Section 20. Those HEIs whose COD/COE applications were disapproved for AY 2018-2019 shall still comply with Sections 19.1 and 19.2.

Section 20. Application Workbook for AY 2018-2019

HEIs currently offering the B.S.M.E. program for AY 2018-2019 shall be made to complete a new Application Workbook (AW-2018- HEI-BSME) which shall be made available through CHED or downloadable from the CHED-TPET website. The Application Workbook shall be completed and submitted to CHED or uploaded to the CHED-TPET website before the start of AY 2018-2019.

Section 21. Approval of Application

All HEIs with BSME programs with COE or COD status submitting their completed Application Workbooks shall automatically receive certifications from CHED and shall be given approval to implement their programs beginning AY 2018-2019.

Other concerned HEIs which have submitted their CMO Monitoring Workbooks, Self-Assessment Rubrics, and Application Workbook shall be given conditional approval by the CHED to start offering their new BSME Curriculum following this CMO effective AY 2018-2019. CHED shall, however, conduct monitoring of HEIs to assure complete compliance of this PSG within the transitory period, during which the HEI with BSME programs of weak implementation may be asked to submit developmental plans, which shall be subject to constant monitoring.

ARTICLE VIII
TRANSITORY, REPEALING and EFFECTIVITY PROVISIONS

Section 22. Transitory Provision

All private HEIs, state universities and colleges (SUCs) and local universities and colleges (LUCs) with existing authorization to operate the Bachelor of Science in Mechanical Engineering program are hereby given a period of three (3) years from the effectivity thereof to fully comply with all the requirements in this CMO. However, the prescribed minimum curricular requirements in this CMO shall be implemented starting AY 2018-2019.

Section 23. Repealing Clause

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

All CHED issuances or part thereof inconsistent with the provision in this CMO shall be deemed modified or repealed

Section 24. Effectivity Clause

This CMO shall take effect fifteen (15) days after its publication in the Official Gazette or in a newspaper of general circulation. This CMO shall be implemented beginning **AY 2018-2019**.

Quezon City, Philippines December 4, 2017

For the Commission:

PATRICIA B. LICUANAN, Ph.D.
Chairperson

Attachments:
Annex I – Competency Standards
Annex II – Minimum Program Outcomes and a Sample Curriculum Map
Annex III – Sample Course Specifications
Annex IV – Laboratory Equipment
Annex V – Sample Syllabus

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, mechanical engineers design space vehicles, computers, power plants, intelligent machines and robots, automobiles, trains, airplanes, furnaces, and air - conditioners. Mechanical engineers work on jet engine

ANNEX I - COMPETENCY STANDARDS
ATTRIBUTES AND COMPETENCIES OF A MECHANICAL ENGINEER

	ATTRIBUTES	COMPETENCY LEVEL		
		NEW GRADUATE	1 - 7 YEARS ENGG. EXPERIENCE	ASEAN/APEC ENGINEER
1	Apply knowledge of mathematics, natural, physical, and applied sciences, information technology and other engineering principles	Understand the principles of mathematics, natural, physical, and applied sciences including information technology. Determine relevant and appropriate engineering principles and techniques that can be used to address engineering concerns related to thermal and mechanical design.	Use relevant and appropriate engineering principles and techniques in addressing concerns related to thermal and mechanical design and operations improvement and optimization. Develop simple computer programs to solve mechanical engineering problems.	Propose innovations in thermal and mechanical design and operations improvement and optimization and impart these to peers. Develop and continually upgrade proficiency in numerical and computational modeling in solving mechanical engineering problems.

2	Identify, formulate, and analyze complex engineering problems using the principles of mathematics, natural sciences and engineering sciences.	Use relevant information gathered from research literature and other available technological information sources in coming out with solutions to complex engineering problems.	Apply relevant information gathered from research literature and other technological advances in the design of machines and operations improvement and optimization.	Consolidate results of research and technical information in formulating solutions to thermal and mechanical engineering design. Impart these technological advances to peers.
3	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Study, investigate and gather data related to complex engineering problems and propose solutions based on the fundamentals of engineering principles while incorporating ethics, safety and environmental considerations.	Study, investigate and gather data related to problems in thermal and mechanical engineering designs and prepare proposals to implement solutions while incorporating ethics, safety and environmental considerations.	Consolidate studies related to thermal and mechanical engineering design and operation. Specialize in specific fields of practice in the mechanical engineering and use the technical expertise in the design of solutions to applicable complex engineering problems. Prepare project proposals, budget and reports related to improvements and optimization of thermal and machine design and operations. Impart learnings to peers.

4	Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information.	Conceptualize, formulate and implement design of experiments in a standard scientific manner in conducting investigations of complex engineering problems with consideration of cost, quality, security, and environmental impact. Recommend valid conclusions based on gathered information and results of investigation.	Use available database information, coordinate with other technical experts, plan and design experiments in conducting investigations of complex engineering problems. Prepare reports and make presentations to concerned entities on the proposed solutions to the complex engineering problems.	Organize teams of experts, plan and design experiments in conducting investigations of complex engineering problems. Prepare feasibility, optimization reports, implementation plans and make presentations to the concerned entities on the proposed solutions to the complex engineering problems.
5	Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to solve complex engineering problems, with an understanding of the limitations.	Be familiar with the appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. Recommend the applicable modern tools that can be used to solve complex engineering problems.	Be familiar with the appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations. Consolidate applicable techniques and modern tools that can be used to solve complex engineering problems.	Be familiarized with applicable modern tools and techniques to solve operational problems taking into consideration process limitations. Use industrial experience in conjunction with technical expertise and appropriate modern tools in solving complex engineering problems. Prepare reports and recommendations and present these to the concerned entities.

6	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems.	Be familiar with relevant policies, laws, regulations and technical standards locally in conjunction with the mechanical engineering professional practice. Make a personal commitment to societal, health, safety, legal and cultural issues recognizing obligations to society, subordinates, and the environment.	Be familiar with relevant policies, laws, regulations and technical standards both locally and internationally in conjunction with the mechanical engineering professional practice. Prepare plans and designs to address problems related to thermal and industrial plant operations while taking into consideration ethical and environmental concerns. Impart learning to peers.	Be familiar with relevant policies, laws, regulations and technical standards both locally and internationally in conjunction with the mechanical engineering professional practice. Be familiar with specific country regulations on professional engineering practice in implementing solutions to complex engineering problems. Prepare plans and designs to address problems related to thermal and industrial plant operations while taking into consideration ethical and environmental concerns. Impart learning to peers.

7	Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.	Be familiar with relevant applicable technical and engineering standards that can be applied in professional mechanical engineering practice. Assess the effects of professional engineering work on process operational problems. Gather relevant data in relation to the professional engineering work.	Be familiar with relevant applicable technical and engineering standards that can be applied in professional mechanical engineering practice. Use gained experience in industrial professional practice to measure impacts on society and environment..	Be familiar with relevant applicable technical and engineering standards that can be applied in professional mechanical engineering practice. Use gained experience in industrial professional practice to measure impacts on society and environment. Do research, develop projects and prepare implementation plans to implement and assess professional engineering works in relation to complex engineering problems. Impart learning to peers.

8	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.	Be familiar with the Mechanical Engineering Code of Ethics. Apply ethical principles in conjunction with engineering practice.	Be familiar with the Mechanical Engineering Code of Ethics. Be familiar with corporate and industrial policies. Apply ethical principles in conjunction with engineering practice incorporating public safety as a priority. Be an example to upcoming engineers in terms of integrity and ethics.	Be familiar with the Mechanical Engineers Code of Ethics. Be familiar with corporate and industrial policies. Apply ethical principles in conjunction with engineering practice incorporating public safety as a priority. Be an example to upcoming engineers in terms of integrity and ethics. Exemplify ethical values through participation in socially relevant projects that contribute to national development. Impart learning to peers.
9	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	Perform functions required in the completion of a task as part of a project or endeavor or as an employee of a company. Interact with peers and higher levels in a professional manner. Participate in activities either as a team leader or member and perform designated tasks.	Plan, lead, coordinate and implement designated tasks either as a team leader or member. Interact with a network of professionals and participate in projects or activities. Handle small to medium-sized projects.	Supervise and manage processes, people and facilities locally or internationally enabling efficiency, improved performance, business profitability and safety. Train other engineers.

10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	Prepare reports, presentations and other engineering documents in an organized way and relay information related to these effectively. Communicate clearly both verbally and in written form all instructions to peers, subordinates and superiors as may be deemed necessary. Organize, coordinate and implement activities or projects in a clear way.	Prepare reports, presentations and other engineering documents in an organized way and relay information related to these effectively. Prepare policies, procedures and other documents related to an activity or project and cascade to subordinates, peers and superiors effectively. Conduct trainings to subordinates and peers. Communicate clearly with legal entities/ authorities regarding engineering activities.	Consolidate reports and make presentations to peers and superiors on projects or on assigned endeavors . Conduct trainings to subordinates, peers and superiors. Communicate and coordinate clearly and act as liaison officer on matters concerning legal or regulatory issues. Prepare policies, rules, regulations, instructions, procedures and implements them.
11	Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	Plan, lead, organize and control small projects or tasks as may be deemed necessary in the practice of mechanical engineering.	Plan, lead, organize and control small to medium-sized projects or tasks as may be deemed necessary in the practice of mechanical engineering. Manage financial aspects of the project. Supervise subordinates and peers when needed. Prepare reports related to projects.	Manage and implement medium-sized to major projects or tasks as may be deemed necessary in the practice of mechanical engineering. Manage financial aspects of the project. Manage supervisors and peers. Prepare reports related to projects.

12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	Attend trainings, seminars, conferences or participate in projects that encourage continued learning in the mechanical engineering profession. Pursue graduate studies.	Attend trainings, seminars, conferences and participate in professional organizations that encourage continued learning in the mechanical engineering profession Pursue graduate studies. Comply with CPD units required annually. Conduct research studies and impart results to peers.	Attend trainings, seminars, conferences and participate in professional organizations that encourage continued learning in the mechanical engineering profession. Prepare modules for training peers, subordinates and students. Organize seminars, trainings or conferences. Publish research papers.

ANNEX II

B.S. Mechanical Engineering Program Curriculum Map

Program Outcomes

By the time of graduation, the students of the program shall have the ability to:

a. apply knowledge of mathematics and science to solve complex mechanical engineering problems;

b. design and conduct experiments, as well as to analyze and interpret data;

c. design a system, component, or process to meet desired needs within realistic constraints, in accordance with standards;

d. function in multidisciplinary and multi-cultural teams;

e. identify, formulate, and solve complex mechanical engineering problems;

f. understand professional and ethical responsibility;

g. communicate effectively;

h. understand the impact of mechanical engineering solutions in a global, economic, environmental, and societal context;

i. recognize the need for, and engage in life-long learning;

j. know contemporary issues;

k. use techniques, skills, and modern engineering tools necessary for mechanical engineering practice;

l. know and understand engineering and management principles as a member and leader of a team, and to manage projects in a multidisciplinary environment;

Sample Curriculum Map

LEGEND

Code	Descriptor
I	Introductory Course
E	Enabling Course
D	Demonstrating Course
Code	**Definition**
I	An introductory course to an outcome
E	A course that strengthens the outcome
D	A course demonstrating an outcome

2018 Sample BSME Curriculum Map

I. TECHNICAL COURSES

A. Mathematics

COURSES	*Relationship to Program Outcomes*											
	a	b	c	d	e	f	g	h	i	j	k	l
Calculus 1	I											
Calculus 2	I											
Differential Equations	I											
Engineering Data Analysis	I	I										

B. Natural and Physical Sciences

COURSES	*Relationship to Program Outcomes*											
	a	b	c	d	e	f	g	h	i	j	k	l
Chemistry for Engineers	I	I									I	
Physics for Engineers	I	I									I	

C. Basic Engineering Sciences

COURSES	*Relationship to Program Outcomes*											
	a	b	c	d	e	f	g	h	i	j	k	l
Engineering Drawing	I										I	
Computer -.Aided Drafting	I						I				I	
Computer Fundamentals and Programming	I										I	
Statics of Rigid Bodies	E											
Dynamic of Rigid Bodies	E											
Mechanics of Deformable Bodies	E											
Engineering Economics					E						E	
Engineering Management									I			I

D. Allied Courses

COURSES	*Relationship to Program Outcomes*											
	a	b	c	d	e	f	g	h	i	j	k	l
Basic Electrical Engineering	E			I							I	
Basic Electronics	E			I							I	
DC and AC Machinery	E			I							I	
Technopreneurship		I										I

E. Fundamental ME Courses

COURSES	*Relationship to Program Outcomes*											
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**J**	**k**	**l**
Mechanical Engineering Orientation				I		I	I	I				
Workshop Theory and Practice			I								I	
Machine Shop Theory			E								E	
Thermodynamics 1	I				I							
Thermodynamics 2	I				I							
Advanced Mathematics for ME	E											
Heat Transfer	E				E							
Fluid Mechanics	E				E							
Vibration Engineering	E				E							
Machine Elements	E				E							
Methods of Research for ME				I	I	I	I		I			
Refrigeration Systems	E		E		E							
Airconditioning and Ventilation Systems	E		E		E							
Fluid Machineries	E				E							
Combustion Engineering	E				E							
Materials Science and Engineering for ME	E	E		E			E					
Computer Applications for ME	E		E		E							
Mechanical Engineering Elective 1	E									E		L
Mechanical Engineering Elective 2	E									E		L
Mechanical Engineerring Laboratory 1		I		I			I					
Mechanical Engineerring Laboratory 2		E		E			E					
Control Engineering	E				E			E				
Control Engineering Laboratory		E						E				E
Manufacturing and Industrial Processes with Plant Visits	E				E			E				
Basic Occupational Safety and Health					E	E	E			E		

F. Professional ME Courses

COURSES	*Relationship to Program Outcomes*											
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
ME Project Study 1	E	E	E	E		E	E				E	
ME Project Study 2	D	D	D	D		D	D				D	
Machine Design 1	D		D		D							
Machine Design 2	D		D		D							
Industrial Plant Engineering	D		D		D			D				
Power Plant Design with Renewable Energy	D		D		D			D				
Mechanical Engineering Laboratory 3			D		D		D					
ME Laws, Ethics, Codes and Standards						E	E			E		

II. NON- TECHNICAL COURSES

A. General Education Courses

COURSES	*Relationship to Program Outcomes*											
	a	b	c	d	e	f	g	h	i	j	k	l
Purposive Communication						I	I					
Mathematics in the Modern World	I			I								
Life and Works of Rizal				I					I	I		
Understanding the Self									I	I		
Arts Appreciation				I					I	I		
Ethics						I	I	I				
Readings in Philippine History				I					I	I		
Contemporary World								I	I	I		
Science, Technology and Society								I	I	I		
GEC Elective				I				I		I		
GEC Elective				I				I		I		
GEC Elective				I				I		I		
Phyiscal Education 1, 2, 3, & 4 (2 units each)				I								
NSTP 1 & 2 (3 units each)				I						I		

ANNEX III - COURSE SPECIFICATIONS Bachelor of Science in Mechanical Engineering

1. TECHNICAL COURSES

A. MATHEMATICS

Course Name	CALCULUS 1
Course Description	An introductory course covering the core concepts of limit, continuity and differentiability of functions involving one or more variables. This also includes the application of differential calculations in solving problems on optimization, rates of change, related rates, tangents and normal, and approximations; partial differentiation and transcendental curve tracing.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	
Program Outcomes Link(s)	a-l
Course Outcomes	At the end of the course, the students must be able to: 1. Differentiate algebraic and transcendental functions 2. Apply the concept of differentiation in solving word problems 3. Analyze and trace transcendental curves
Course Outline	1. Functions 2. Continuity and Limits 3. The Derivative 4. The Slope 5. Rate of Change 6. The Chain Rule and the General Power Rule 7. Implicit Differentiation 8. Higher – Order derivatives 9. Polynomial Curves 10. Applications of the Derivative 11. The Differential 12. Derivatives of Trigonometric Functions 13. Derivative of Inverse Trigonometric Functions 14. Derivative of Logarithmic and Exponential Functions 15. Derivative of the Hyperbolic Functions 16. Solutions of Equations 17. Transcendental Curve Tracing 18. Parametric Equations 19. Partial differentiation

Course Name	CALCULUS 2
Course Description	The course introduces the concept of integration and its application to some physical problems such as evaluation of areas, volumes of revolution, force, and work. The fundamental formulas and various techniques of integration are taken up and applied to both single variable and multi-variable functions. The course also includes tracing of functions of two variables for a better appreciation of the interpretation of the double and triple integral as volume of a three-dimensional region bounded by two or more surfaces.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 1
Program Outcomes Link(s) Link(s)	a-l
Course Outcomes	After completing this course, the student must be able to: 1. Apply integration to the evaluation of areas, volumes of revolution, force and work 2. Use integration techniques on single and multi-variable functions 3. Explain the physical interpretation of the double and triple integral
Course Outline	I. Integration Concepts/Formulas A. Anti-differentiation B. Indefinite Integrals C. Simple Power Formula D. Simple Trigonometric Functions E. Logarithmic Function F. Exponential Function G. Inverse Trigonometric Functions H. Hyperbolic Functions (sinh u & cosh u only) I. General Power formula (include Substitution Rule) J. Constant of Integration K. Definite Integral (include absolute, odd & even functions) II. Integration Techniques A. Integration by Parts B. Trigonometric Integrals C. Trigonometric Substitution D. Rational Functions E. Rationalizing Substitution III. Improper Integrals IV. Application of Definite Integral A. Plane Area B. Areas between Curves V. Other Applications A. Volumes B. Work C. Hydrostatic Pressure VI. Multiple Integrals (Inversion of order/ change of coordinates)

	A. Double Intecrals B. Triple Integrals VII. Surface Tracing A. Planes B. Spheres C. Cylinders D. Quadric Surfaces E. Intersection of Surfaces VIII. Multiple Integrals as Volume A. Double Integrals B. Triple Integrals

Course Name	**DIFFERENTIAL EQUATIONS**
Course Description	This course is intended for all engineering students to have a firm foundation on differential equations in preparation for their degree-specific advanced mathematics courses. It covers first order differential equations, nth order linear differential equations and systems of first order linear differential equations. It also introduces the concept of Laplace Transforms in solving differential equations. The students are expected to be able to recognize different kinds of differential equations, determine the existence and uniqueness of solution, select the appropriate methods of solution and interpret the obtained solution. Students are also expected to relate differential equations to various practical engineering and scientific problems as well as employ computer technology in solving and verifying solutions
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 2
Program Outcomes Link(s)	a-l
Course Outcomes	After completing this course, the student must be able to: 1. Apply integration for the evaluation of areas, volumes of revolution, force and work 2. Use integration techniques on single and multi-variable functions 3. Explain the physical interpretation of the double and triple integral
Course Outline	1. Introduction / Definition 1.1. Definition and Classifications of Differential Equations (DE) 1.2. Solution of a DE 2. Solution of some 1st order DE 2.1. Variable Separable 2.2. Exact Equation 2.3. Linear Equation 2.4. Substitution Methods 2.4.1. Homogeneous Coefficients 2.4.2. Bernoulli's Equation 2.4.3. Other Substitution Methods 2.5. Mixed Problems (method not pre-identified) 2.6. Introduction to Use of Computer in Solving Differential

	Equations 3. Application of 1st Order Differential Equations 3.1. Decomposition /Growth 3.2. Newton's Law of Cooling 3.3. Mixing (non-reacting fluids) 3.4. Electric Circuits 4. Linear Differential Equation of Order n 4.1. Introduction 4.1.1. Standard form of a n^{th} order Linear DE 4.1.2. Differential Operators 4.1.3. Principle of Superposition 4.1.4. Linear Independence of a Set of Functions 4.2. Homogeneous Linear Differential Equation with Constant Coefficients 4.2.1. Solution of a Homogeneous Linear Ordinary DE 4.2.2. Initial and Boundary Value Problems 4.3. Non-homogeneous Differential Equation with Constant Coefficients 4.3.1. Form of the General Solution 4.3.2. Solution by Method of Undetermined Coefficients 4.3.3. Solution by Variation of Parameters 4.3.4. Mixed Problems 4.4. Solution of Higher Order Differential Equations using Computer 5. Laplace Transforms of Functions 5.1. Definition 5.2. Transform of Elementary Functions 5.3. Transform of $e^{at}f(t)$ – Theorem 5.4. Transform of $t^n f(t)$ – Derivatives of Transforms 5.5. Inverse Transforms 5.6. Laplace and Inverse Laplace Transforms using a Computer 5.7. Transforms of Derivatives 5.8. Initial Value Problems

Course Name	**ENGINEERING DATA ANALYSIS**
Course Description	This course is designed for undergraduate engineering students with emphasis on problem solving related to societal issues that engineers and scientists are called upon to solve. It introduces different methods of data collection and the suitability of using a particular method for a given situation. The relationship of probability to statistics is also discussed, providing students with the tools they need to understand how "chance" plays a role in statistical analysis. Probability distributions of random variables and their uses are also considered, along with a discussion of linear functions of random variables within the context of their application to data analysis and inference. The course also includes estimation techniques for unknown parameters; and hypothesis testing used in making inferences from sample to population; inference for regression parameters and build models for estimating means and predicting future values of key variables under study. Finally, statistically based experimental design techniques and analysis of outcomes of experiments are discussed with the aid of statistical

	software.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	Calculus 1
Program Outcomes Link(s)	a-I, b-I
Course Outcomes	After completing this course, the student must be able to: 1. Apply statistical methods in the analysis of data 2. Design experiments involving several factors
Course Outline	1. Obtaining Data 1.1. Methods of Data Collection 1.2. Planning and Conducting Surveys 1.3. Planning and Conducting Experiments: Introduction to Design of Experiments 2. Probability 2.1. Sample Space and Relationships among Events 2.2. Counting Rules Useful in Probability 2.3. Rules of Probability 3. Discrete Probability Distributions 3.1. Random Variables and their Probability Distributions 3.2. Cumulative Distribution Functions 3.3. Expected Values of Random Variables 3.4. The Binomial Distribution 3.5. The Poisson Distribution 4. Continuous Probability Distribution 4.1. Continuous Random Variables and their Probability Distribution 4.2. Expected Values of Continuous Random Variables 4.3. Normal Distribution 4.4. Normal Approximation to the Binomial and Poisson Distribution 4.5. Exponential Distribution 5. Joint Probability Distribution 5.1. Two or Random Variables 5.1.1. Joint Probability Distributions 5.1.2. Marginal Probability Distribution 5.1.3. Conditional Probability Distribution 5.1.4. More than Two Random Variables 5.2. Linear Functions of Random Variables 5.3. General Functions of Random Variables 6. Sampling Distributions and Point Estimation of Parameters 6.1. Point Estimation 6.2. Sampling Distribution and the Central Limit Theorem 6.3. General Concept of Point Estimation 6.3.1. Unbiased Estimator 6.3.2. Variance of a Point Estimator 6.3.3. Standard Error 6.3.4. Mean Squared Error of an Estimator 7. Statistical Intervals 7.1. Confidence Intervals: Single Sample

	7.2. Confidence Intervals: Multiple Samples 7.3. Prediction Intervals 7.4. Tolerance Intervals 8. Test of Hypothesis for a Single Sample 8.1. Hypothesis Testing 8.1.1. One-sided and Two-sided Hypothesis 8.1.2. P-value in Hypothesis Tests 8.1.3. General Procedure for Test of Hypothesis 8.2. Test on the Mean of a Normal Distribution, Variance Known 8.3. Test on the Mean of a Normal Distribution, Variance Unknown 8.4. Test on the Variance and Statistical Deviation of a Normal Distribution 8.5. Test on a Population Proportion 9. Statistical Inference of Two Samples 9.1. Inference on the Difference in Means of Two Normal Distributions, Variances Known 9.2. Inference on the Difference in Means of Two Normal Distributions, Variances Unknown 9.3. Inference on the Variance of Two Normal Distributions 9.4. Inference on Two Population Proportions 10. Simple Linear Regression and Correlation 10.1. Empirical Models 10.2. Regression: Modelling Linear Relationships – The Least-Squares Approach 10.3. Correlation: Estimating the Strength of Linear Relation 10.4. Hypothesis Tests in Simple Linear Regression 10.4.1. Use of t-tests 10.4.2. Analysis of Variance Approach to Test Significance of Regression 10.5. Prediction of New Observations 10.6. Adequacy of the Regression Model 10.6.1. Residual Analysis 10.6.2. Coefficient of Determination 10.7. Correlation

B. NATURAL/PHYSICAL SCIENCES

Course Name	**CHEMISTRY FOR ENGINEERS**
Course Description	This course provides students with core concepts of chemistry that are important in the practice of engineering profession.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours per week
Prerequisites	None
Co-requisites	Chemistry for Engineers Lab

Program Outcome/s Addressed by the Course	a-I
Course Outcomes	At the end of the course, the students must be able to: 1. Discuss the application of chemistry in relation to the generation of energy 2. Explain the chemical principles and concepts of structures and bonding of common materials 3. Discuss the chemical processes that takes place in the environment 4. Identify key chemistry concepts related to the specific field of engineering
Course Outline	1. Energy a. Electrochemical energy b. Nuclear chemistry and energy c. Fuels 2. The Chemistry of Engineering Materials d. Basic Concepts of Crystal Structure e. Metals f. Polymers g. Engineered Nanomaterials 3. The Chemistry of the Environment h. The Chemistry of the atmosphere i. The Chemistry of Water j. Soil chemistry 4. Chemical Safety 5. Special Topics specific to field of expertise
Laboratory Equipment	None

Course Name	**CHEMISTRY FOR ENGINEERS (Laboratory)**
Course Description	A fundamental laboratory course designed to relate and apply the principles and theories in chemistry to engineering practices. It is a combination of experimental and calculation laboratory.
Number of Units for Lecture and Laboratory	1 laboratory unit
Number of Contact Hours per Week	3 hours per week
Prerequisites	None
Co-requisites	Chemistry for Engineers (Lecture)
Program Outcome/s Addressed by the Course	a-I, b-I, k-I
Course Outcomes	At the end of the course, the students must be able to:

	1. Explicitly state experimental observation in relation to specific principles and fundamental concepts of chemistry 2. Interpret results clearly obtained from the experiments 3. Answer questions related to the performed experiment 4. Develop critical and technical communication skills 5. Explain the mechanics of alpha, beta and gamma decay as well as the correlation between the half-lives 6. Understand the natural environment and its relationships with human activities. 7. Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.
Course Outline	EXPERIMENTS: 1. Calorimetry 2. Heat of Combustion 3. Metals and Some Aspects of Corrosion 4. Mechanical Properties of Materials 5. Water: Its Properties and Purification 6. Determination of the Dissolved Oxygen Content of Water 7. Cigarette Smoking and Air Pollution ACTIVITIES: 1. Nuclear Reactions, Binding Energy and Rate of Decay 2. Crystal Lattices and Unit Cells 3. Community Immersion: Care for the Environment
Laboratory Equipment	Refer to Annex of Lab Requirements

Course Name	**PHYSICS FOR ENGINEERS**
Course Description	Vectors; kinematics; dynamics; work, energy, and power; impulse and momentum; rotation; dynamics of rotation; elasticity; and oscillation. 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: 3 units lecture, 1 unit laboratory
Number of Contact Hours per Week	6 hours: 3 hours lecture, 3 hours laboratory
Prerequisites	Calculus 1: Co-requisite –Calculus 2
Program Outcome/s Addressed by the Course	a-l, b-l, k-l
Course Outcomes	After completing this course, the student must be able to: 1. Use calculus to solve problems in force statics and kinematics; 2. Apply the Newton's Laws of Motion; 3. Use calculus to solve work and energy problems; 4. Apply the law of conservation of energy to problems;

	5. Solve problems on impulse and momentum and collisions; 6. Determine the stress and strain on a body; 7. Solve simple harmonic motion applications; 8. Describe the characteristics of fluids at rest and in motion; 9. Solve basic problems in fluid statics and kinematics 10. Describe the three methods of heat transfer; 11. Solve basic problems in heat transfer; 12. Discuss the properties of waves, modes of vibration of strings and air columns; 13. Define electric current, electric resistance and voltage; 14. Compute the electric force between electric charges; 15. Solve problems on resistance and cells in series and parallel; 16. State Kirchhoff's rules and apply them in a given circuit; 17. Describe electromagnetism and apply its principles to problem on magnetic field and torque. 18. Describe image formation by mirrors and lenses and solve basic optics problems
Course Outline	1. Work, Energy and Power 2. Impulse and Momentum 3. Kinematics 4. Dynamics 5. Rotation 6. Dynamics of Rotation 7. Elasticity 8. Oscillations 9. Fluids 10. Heat Transfer 11. Waves 12. Electrostatics 13. Electricity 14. Magnetism 15. Optics
Laboratory Equipment	Physics Laboratory (see Annex IV)

C. BASIC ENGINEERING SCIENCES

Course Name	**ENGINEERING DRAWING**
Course Description	The course deals with the 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
Program Outcomes Link(s)	a-l, k-l
Course Outcomes	After completing this course, the student must be able to: 1. Use basic drafting instruments properly 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-AIDED DRAFTING**
Course Description	The course deals with the 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	Engineering Drawing
Program Outcomes Link(s)	a-l, g-l, k-l
Course Outcomes	After completing this course, the student must be able to: 1. Identify the important tools used to create technical drawings in CAD; 2. Create electronic drawings (e-drawing) using CAD; and, 3. Apply different CAD tools in the preparation of engineering drawings and plans.
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	The course deals with the forces acting on non-moving bodies. It covers concurrent and non-concurrent forces, operation with the free body concepts, equilibrium of coplanar and non-coplanar systems, friction forces, centroids 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 for Engineers, Calculus 2
Program Outcomes Link(s)	a-E
Course Outcomes	After completing this course, the student must be able to: 1. Undertake vector operations such as vector cross and dot product; 2. Determine forces of 2D and 3D structures; 3. Apply the principles of static, wedge and belt friction to solve problems; 4. Determine centroids, center of mass and center of gravity of objects; and, 5. Determine moment of inertia, mass moment of inertia.
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. Beams; Shear and Bending Moment Diagrams
Laboratory Equipment	None

Course Name	**DYNAMICS OF RIGID BODIES**
Course Description	The course deals with the forces acting on bodies in motion. It includes kinematics of machines and kinetics of particles of rigid bodies such as rectilinear and curvilinear translation and rotational motions.
Number of Units for Lecture and Laboratory	Lecture- 2 units
Number of Contact Hours per Week	Lecture- 2 hours
Prerequisite	Statics of Rigid Bodies
Program Outcomes link(s)	a-E
Course Outcomes	After completing this course, the student must be able to: 1. Apply the principles governing the motion of particles, velocity and acceleration in solving engineering problems; 2. Apply the principles of Newton's Second Law in solving engineering problems; 3. Apply the principles of kinetics of particles, kinematics of rigid bodies and momentum methods in solving engineering problems.
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. Dynamic Equilibrium 13.4. Angular Momentum of Particle, Rate of Change of Angular Momentum 13.5. Equations in Terms of Radial and Transverse Components 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 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 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. Angular Momentum of a Rigid Body in Plane Motion 17.2. Plane Motion of a Rigid Body. D' Alembert's Principle 17.3. Solution of Problems involving the Motion of a Rigid Bodies 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 Principle of Impulse and Momentum
Laboratory Equipment	None

Course Name	**MECHANICS OF DEFORMABLE BODIES**
Course Description	The course covers the fundamental concepts of stresses and strains such as axial stress, shearing stress, bearing stress, torsion, flexural stress and strain-stress relationship.
Number of Units for Lecture and Laboratory	Lecture- 3 units
Number of Contact Hours per Week	Lecture- 3 hours
Prerequisite	Statics of Rigid Bodies
Program Outcomes Link(s)	a-E
Course Outcomes	After completing this course, the student must be able to: 1. Apply 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 ECONOMICS**
Course Description	This course deals with the study of concepts of the time value of money and equivalence; basic economic study methods; decisions under certainty; decisions recognizing risk; and decisions admitting uncertainty.
Number of Units for Lecture and Laboratory	3 units lecture
Number of Contact Hours per Week	3 hours lecture
Prerequisite	
Program Outcomes Link(s)	e-E, k-E
Course Outcomes	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 Economics 1.3. Engineering Economics and the Design Process 1.4. Cost Concepts for Decision Making 1.5. Present Economic 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. Economic Study Methods 3.1. The Minimum Attractive Rate of Return 3.2. Basic Economic Study Methods: Present Worth, Future Worth, Annual Worth, Internal Rate of Return, External Rate of Return 3.3. Other Methods: Discounted Payback Period, Benefit/Cost Ratio 4. Decisions Under Certainty 4.1. Evaluation of Mutually Exclusive Alternatives 4.2. Evaluation of Independent Projects 4.3. Effects of Inflation 4.4. Depreciation and After-Tax Economic Analysis 4.5. Replacement Studies 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

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- 2 units
Number of Contact Hours per Week	Lecture- 2 hours
Prerequisite	
Program Outcomes Link(s)	i – I, l - I
Course Outcomes	After completing this course, the student must be able to: 1. Explain the basic concepts of engineering management;

	2. Apply the principles of engineering management to analyze case studies.
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 Name	**TECHNOPRENEURSHIP 101**
Course Description	*Technopreneurship* is a philosophy, a way of building a career or perspective in life. The course covers the value of professional and life skills in entrepreneurial thought, investment decisions, and action that students can utilize in starting technology companies or executing R&D projects in companies as they start their careers. The net result is a positive outlook towards wealth creation, high value adding, and wellness in society.
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture - 3 hours
Prerequisite	None
Course Learning Outcomes	The course should enable the student to: 1) evaluate and define the market needs 2) solicit and apply feedback from mentors, customers and other stakeholders 3) experience the dynamics of participating on a business team, 4) pitch a business plan for a technology idea 5) develop an initial idea into a "pretotype"
Course Outline	1. Introduction o Entrepreneurial Mindset o Innovation and Ideas o Products and Services o Team Formation 2. Customers 3. Value Proposition 4. Market Identification and Analysis 5. Creating Competitive Advantage 6. Business Models 7. Introduction to Intellectual Property 8. Execution and Business Plan

	9. Financial Analysis and Accounting Basics 10. Raising Capital 11. Ethics, social responsibility, and Globalization
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 for Engineers, Calculus 2
Program Outcomes Link(s)	a – E, d – I, k – I
Course Outcomes	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. Familiarize 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
Program Outcomes Link(s)	a – E, d – I, k – I
Course Outcomes	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 –2 units Laboratory – 1 unit
Number of Contact Hours per Week	Lecture –3 hours Laboratory - 3 hours
Prerequisites	Basic Electrical Engineering
Program Outcomes Link(s)	a – E, d – I, k – I
Course Outcomes	After completing this course, the student must be able to: 1. Explain the characteristics of different types of DC Generators. 2. Determine the effects of DC excitation upon the power delivered by an alternator 3. Demonstrate how to synchronize an alternator to the electric power utility system 4. Demonstrate 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	**MECHANICAL ENGINEERING ORIENTATION**
Course Description	The course introduces mechanical engineering (ME) as a discipline and its various applications. It also discusses ME as a profession with emphasis on the requirements for professional practice as well as career opportunities. The course also provides venues to develop engineering skills in order to succeed in engineering studies
Number of Units for Lecture and Laboratory	Lecture -1 unit
Number of Contact Hours per Week	Lecture - 1 hour
Prerequisites	None
Program Outcomes Link(s)	d-I, f-I, g-I, h-I
Course Outcomes	After completing this course, the student shall be able to:

	1. Explain the field of mechanical engineering and its applications. 2. Explain engineering profession and the requirements for professional practice. 3. Define mechanical engineering as a career and identify the career opportunities for mechanical engineers. 4. Apply engineering skills to an engineering design project.
Course Outline	1. Mechanical Engineering Program 2. Teamwork and Communication Skills 3. Engineering Profession 4. Engineering as a Career 5. Developing God Study habits 6. Engineering Design and Creativity
Laboratory Equipment	None

Course Name	**ADVANCED MATHEMATICS FOR ME**
Course Description	Numerical techniques used in engineering applications. Finding roots of equations, curve fitting, interpolation, numerical differentiation and integration, systems of linear algebraic equations, solution to non-linear equations, and solutions to ordinary differential equations.
Number of Units for Lecture and Laboratory	Lecture – 3 units
Number of Contact Hours per week	Lecture – 3 hours
Prerequisite	Differential Equations
Program Outcomes Link(s)	a-E
Course Outcomes	After completing this course, the student must be able to: 1. Solve problems in mathematics utilizing the different parameters, laws, theorems and methods of solutions in advance mathematics 2. Use numerical methods to solve engineering problems 3. Select or design the most efficient numerical solution to a problem
Course Outline	1. Numerical methods: Introduction, Discrete Algebra, Accuracy, Errors 2. Numerical analysis in engineering. The Taylor Series 3. Review of Matrices. Operations, Vectors, Determinants, Rank 4. Solutions to linear systems of equations 5. Roots of Equations 6. Interpolation. Least square approximations. Curve Fitting. Optimization 7. Numerical differentiation 8. Numerical integration methods (time integration methods, Runge Kutta) 9. Solution to non-linear equations 10. Numerical solution to Ordinary Differential Equations (ODE) and systems of ODE 11. Numerical solution to Partial Differential Equations (Advanced topic – may be omitted)

	12. Computer programming exercises and examples.
Laboratory Equipment	NONE

Course Name	**METHODS OF RESEARCH FOR ME**
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 unit
Number of Contact Hours per week	Lecture - 1 hour
Prerequisite	Engineering Data Analysis
Program Outcomes Link(s)	d-I, e-I, f-I, g-I, i-I
Course Outcomes	After completing this course, the student must be able to: 1. Explain the research methods and procedures 2. Write a research proposal 3. Formulate a research problem 4. 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 3.1 Experimental Design 3.2 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, inviscid or viscous flow as well as head loss 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, Dynamics of Rigid Bodies
Program Outcomes Link(s)	a-E, e-E
Course Outcomes	After completing this course, the student must be able to: 1. Identify the different fluid properties and the methods of measuring them. 2. Apply the principles of conservation of mass, momentum and energy to fluid systems. 3. Explain the concept of dimensional analysis. 4. Apply the concept of Steady Incompressible Flow in Conduits
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 Π 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** 11. **Special Topics** (Basic Hydraulic Calculation for Fire Sprinkler Lay-out System Using Haze – Williams Equations
Laboratory Equipment	None

Course Name	**MACHINE ELEMENTS**
Course Description	The course deals with the study of mechanisms disregarding the forces and energies that causes the motion. It provides emphasis on the analytical and graphical study of displacement, velocity and acceleration. This also includes the study of the elements of mechanisms such as gears, train, rolling bodies, belt and pulleys, cams and followers.
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
Program Outcomes Link(s)	a-E, e-E

Course Outcomes	After completing this course, the student must be able to: 1. Apply the concepts of kinematics of machineries in the design of machine elements 2. Solve problems in kinematics of machineries using graphical and analytical methods 3. Apply the fundamental principles of Physics and Mathematics in the field of mechanical movement 4. Apply the concepts learned in the design of the different machine elements
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 7. Cam and Follower 8. Rolling Bodies in Pure Contact 9. Gears 10. Gear Train 11. Belts and Pulleys 12. Chains 13. Flexible Connections 14. Stepped Pulleys
Laboratory Equipment	Drafting Tables, computer (optional)

Course Name	**MATERIALS SCIENCE AND ENGINEERING FOR ME**
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 - 2 units Laboratory - 1 unit
Number of Contact Hours per week	Lecture - 2 hrs Laboratory - 3 hrs
Prerequisite	Chemistry for Engineers, Mechanics of Deformable Bodies
Program Outcomes Link(s)	a-E, b-E, d-E, g-E
Course Outcomes	After completing this course, the student must be able to: 1. Evaluate the types, properties and characteristics of engineering materials 2. Identify the different new engineering materials and their industrial usage 3. Evaluate 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 Fatigue Testing 5. Corrosion Prevention and Control 14.1 Significance and Purpose 14.2 Electrochemical nature of aqueous corrosion 14.3 Corrosion rate determinates 14.4 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	Calculus 2, Physics for Engineers
Program Outcomes Link(s)	a-l, e-l

Course Outcomes	After completing this course, the student must be able to: 1. Identify the different properties of pure substance, ideal gas and real gas 2. Apply thermodynamic concepts and principles in analyzing and solving problems. 3. Apply the laws of thermodynamics in analyzing problems. 4. Evaluate the performance of thermodynamic cycles.
Course Outline	12. Introduction 13. Basic Principles, Concepts and definition 14. First Law of Thermodynamics 15. Ideal Gases/ Ideal Gas Laws 16. Processes of Ideal Gases 17. Properties of Pure Substance 18. Processes of Pure Substance 19. Introduction to cycle analysis: Second Law of Thermodynamics 20. Introduction to Gas and vapor cycles 21. 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
Program Outcomes Link(s)	a-I, e-I
Course Outcomes	After completing this course, the student must be able to: 1. Apply the concepts of Thermodynamic in analyzing Power Cycles 2. Determine the physical and thermodynamic properties of ideal gas mixtures, real gases, and mixtures of gases and vapor 3. Evaluate the performance of vapor power cycles and gas power plants and standard air –power cycle
Course Outline	1. Review 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
Program Outcomes Link(s)	a-E, e-E
Course Objectives	After completing this course, the student must be able to: 1. Explain basic combustion and stoichiometric process 2. Perform stoichiometric analysis of various gaseous, liquid and solid fuels 3. Apply thermodynamic principles in analyzing the performance of internal combustion engines. 4. Evaluate the principles, operations, maintenance and design 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
Program Outcomes Link(s)	a-E, e-E
Course Outcomes	After completing this course, the student must be able to: 1. Solve problems involving modes of heat transfer and heat exchangers 2. Perform steady state and unsteady state heat transfer computations. 3. Evaluate the performance of heat exchangers
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 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 - 1 unit
Number of Contact Hours per week	Laboratory - 3 hours
Prerequisite	Thermodynamics 2
Program Outcomes Link(s)	b-I, d-I, g-I

Course Outcomes	After completing this course, the student must be able to: 1. Use measuring instruments in the performance of laboratory exercises. 2. Analyze the significance of the quantities determined by the use of engineering measuring devices. 3. Analyze the properties of fuels and lubricants using different methods. 4. Design an experiment involving measurement of properties
Course Outline	Recommended Experiments (select minimum of 10) 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, Venturi meter 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, Fluid Machinery, Heat Transfer
Program Outcomes Link(s)	b-E, d-E, g-E

Course Objectives	After completing this course, the student must be able to: 1. Perform experiments involving fluid machineries 2. Perform experiments involving heat transfer equipment 3. Analyse the performance of Heat Transfer equipment 4. Analyse the performance of fluid machineries 5. Design an experiment involving heat transfer and / or fluid machineries
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	**MANUFACTURING AND INDUSTRIAL PROCESSES WITH PLANT VISITS**
Course Description	A course dealing with the study of industrial and manufacturing processes and the equipment involved in the processes. This includes plant visit to various manufacturing and power plants.
Number of Units for Lecture and Laboratory	Lecture - 1 unit, Plant visit – 1 unit
Number of Contact Hours per week	Lecture – 1hr, plant visit – 3hours
Prerequisite	
Program Outcomes Link(s)	a-E, e-E, h-E
Course Outcomes	After completing this course, the student must be able to: 1. Discuss the different processes in industrial and manufacturing plants 2. Enumerate and describe the equipment utilized in the different industrial and manufacturing processes 3. Assess the safety and health practices in the different industrial and manufacturing plants during the plant visits
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 5. Plant visits to manufacturing and industrial and manufacturing plants 6. Plumbing
Laboratory Equipment	None

Course Name	**BASIC OCCUPATIONAL SAFETY AND HEALTH**
Course Description	The course tackles key Occupational, Health and Safety (OSH) concepts, principles and practices that are foundational knowledge requirements acceptable in almost all industries. Specifically, it assists learners in identifying the key elements in the OSH situation both here and abroad, determine existing and potential safety health hazards, identify the range of control measures, discuss pertinent provisions of Philippine laws that refer to occupational safety and health, explain key principles in effectively communicating OSH, identify components of effective OSH programs and demonstrate some skills in identifying hazards and corresponding control measures at the workplace
Number of Units for Lecture and Laboratory	Lecture - 3 units
Number of Contact Hours per week	Lecture - 3 Hours
Prerequisite	e-E, f-E, g-E, j-E
Course Outcomes	After completing this course, the student must be able to: 1. Discuss the health and safety concerns in an industrial setting and the importance of promoting safety and health as an engineer's professional and ethical responsibility. 2. Perform safety audit of any of the following: a process, equipment, or an industrial plant. 3. Apply the concepts and principles of industrial safety and health to case studies.
Course Outline	1. Introductory Concepts: Promoting Safety and Health as an Engineer's Professional and Ethical Responsibility 2. Occupational Safety 3. Industrial Hygiene 4. Control Measures for OSH hazards 5. Occupational Health 6. Personal Protective Equipment 7. OSH Programming 8. Training of Personnel on OSH 9. OSH Legislation 10. Plant Visit Simulation 11. Fire Protection
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 - 1 units
Number of Contact Hours per week	Laboratory – 3 hrs
Prerequisite	
Program Outcomes Link(s)	c-I, k-I
Course Outcomes	After completing this course, the student must be able to: 1. Demonstrate proper use of the different tools applicable in basic cutting, joining and forming processes in machine shop practice. 2. Create a project involving the use of the different tools and processes
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
Program Outcomes Link(s)	c-E, k-E

Course Outcomes	After completing this course, the student must be able to: 1. Demonstrate skills in the use of the different machines. 2. Create a project involving the use of the different machines.
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	**CONTROL ENGINEERING**
Course Description	Introduction to linear control systems. Modeling of physical systems. Feedback control systems. Time- and frequency domain analysis of control systems. Stability of control systems. Applications.
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
Program Outcomes Link(s)	a-E, e-E, h-E
Course Outcomes	After completing this course, the student must be able to: 1. Discuss the basic concepts and operating principles of feedback control systems. 2. Explain the dynamic modeling of mechanical, electrical, electro – mechanical, fluid and thermodynamic System in relation to control. 3. Create and use models of physical systems suitable for use in the analysis and design of control systems. 4. Determine the time and frequency-domain responses of first and second-order systems to impulse, step, ramp, and sinusoidal inputs. 5. Apply the concepts of control engineering to a project.
Course Outline	1. Introduction to Control Systems. Open-loop control. Closed-loop control 2. Laplace Transforms 3. Transfer Functions 4. Block Diagrams and Signal Flow Graphs 5. Physical Systems Modeling 6. System stability 7. Root Locus Analysis 8. Time Domain Analysis of Control Systems 9. Frequency Domain Analysis of Control Systems 10. Control System Design. Classical control techniques. PID controllers 11. Introduction to Digital Control. The z-Transform 12. Computer programming exercises and examples (See note 1 below.) 13. Laboratory Exercises (See note 2 below.)
Laboratory	Please see attached Annex IV

Equipment	1. SILAB is recommended which is open source and easy to learn. It can be downloaded from www.scilab.org/. It is the essentially the equivalent of MATLAB. Furthermore, the students can install SCILAB free of charge in their personal computers. 2. A control systems laboratory is recommended but not required. Computer simulations can be used in lieu of a physical laboratory (see note above.) In many cases equipment from other existing mechanical engineering laboratories may be shared (instruments, equipment, etc.) Suggested physical laboratory exercises are: a. Temperature control b. Fluid flow rate control c. Liquid level control d. Motor speed control

Course Name	**FLUID MACHINERIES**
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
Program Outcomes Link(s)	a-E, e-E
Course Outcomes	After completing this course, the student must be able to: 1. Solve problems involving the relationships between speed, quantity of fluid flow, head and power in fluid machinery. 2. Select appropriate fluid machineries in relation to industrial applications. 3. Evaluate the performance 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	Heat Transfer
Program Outcomes Link(s)	a-E, c-E, e-E
Course Outcomes	After completing this course, the student must be able to: 1. Apply the basic mass and heat transfer principles in the analysis of refrigeration systems. 2. Solve problems involving different refrigeration systems. 3. Evaluate and compare the different properties of refrigerants used in refrigeration systems and propose alternative refrigerants 4. Evaluate and compare existing refrigeration systems with other systems under consideration. Make recommendations to improve existing ones
Course Outline	1. Introduction to refrigeration system. 2. Refrigerants 3. Standard and Actual Vapor Compression Cycle 4. Functions and Performance of Compressors 5. Functions and Performance of Evaporators 6. Functions and Performance of Condensers 7. Functions and Performance of Expansion devices 8. Multi-stage refrigeration system. 9. Absorption refrigeration cycle 10. Air cycle refrigeration system 11. Steam jet refrigeration cycle 12. Special Topics in Refrigeration Systems (e.g., Thermoacoustics, Thermoelectric, Cryogenics, Solar Powered Refrigeration systems, etc)
Laboratory Equipment	None

Course Name	**AIR CONDITIONING AND VENTILATION SYSTEMS**
Course Description	The course deals with the psychrometric properties of air; factors affecting human comfort; air distribution and basic duct design; drying, heating and ventilation; cooling load calculations; and, design of an air-conditioning system and its components.
Number of Units for Lecture and Laboratory	Lecture – 3
Number of Contact Hours per week	Lecture – 3 hours
Prerequisite	Refrigeration Systems
Program Outcomes Link(s)	a-E, c-E, e-E

Course Outcomes	After completing this course, the student must be able to: 1. Identify the components of an air-conditioning system and discuss their functions 2. Perform an air-conditioning load calculation 3. Apply the principles of heat transfer and thermodynamic analysis to air-conditioning systems 4. Design a simple air-conditioning system for a given application
Course Outline	1. Air-conditioning system and its psychrometric processes and application 2. Air-conditioning Processes 3. Cooling Towers and Air Dryers 4. Cooling load calculations 5. Air distribution system, duct sizing and equipment specification 6. Refrigerant Piping, Chilled and Cooling Water Piping System, Air Conditioning Equipment Design and Selection, and Air Washers 7. Ventilation 8. Comfort condition and Indoor Air-Quality 9. Introduction to 2010 PSVARE Standard for Energy Efficient Buildings 10. Conventional and alternative air-conditioning systems
Laboratory Equipment	None

Course Name	**VIBRATION ENGINEERING**
Course Description	This course deals with 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.
Number of Units for Lecture and Laboratory	Lecture - 2 units
Number of Contact Hours per week	Lecture - 2 hours
Prerequisite	Differential Equations
Program Outcomes Link(s)	a-E, e-E
Course Outcomes	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 equations with appropriate boundary / initial conditions corresponding to the mechanical system. 3. Evaluate the response for certain simple excitations. 4. Perform 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, Materials Science and Engineering for M.E.
Program Outcomes Link(s)	a-D, c-D, e-D
Course Outcomes	After completing this course, the student must be able to: 1. Apply the principles of machine elements and materials engineering in the design of machine elements 2. Determine the design factor and design stresses, and be able to apply these in the design of machine elements. 3. Solve problems involving different types of stresses. 4. Apply the various codes in the design of machine elements
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 10.1 coil and leaf springs elements 8. Design of Power Screws 8.1 Square thread 8.2 Acme thread 8.3 Buttress thread 9. Gears
Laboratory Equipment	None

Course Name	**MACHINE DESIGN 2**
Course Description	This course is a continuation of machine design 1 which involves the analysis of simple, variable and combined stresses applied to the different machine elements flywheels, brakes and clutches, bearings, flexible power transmissions such as belts, wire ropes and chains. It also includes analysis and synthesis of machineries which consist of two or more machine elements preferably using an application software.
Number of Units for Lecture and Laboratory	Lecture - 2 units Computational Laboratory – 1 unit
Number of Contact Hours per week	Lecture: 2 hrs Computational Laboratory – 3 hrs
Prerequisite	Machine Design 1
Program Outcomes Link(s)	a-D, c-D, e-D
Course Outcomes	After completing this course, the student must be able to: 1. Apply the principles of machine elements and materials engineering in the design of machine elements 2. Determine the design factor and design stresses, and be able to apply these in the design of machine elements. 3. Solve problems involving different types of stresses. 4. Apply the various codes in the design of machine elements 5. Analyze and synthesize machineries
Course Outline	1. Flywheels 2. Brakes and Clutches 3. Bearings 4. Flexible power transmissions such as belts, wire ropes and chains 5. Analysis and Synthesis of Machineries
Laboratory Equipment	Computational Laboratory

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, Air – conditioning and Ventilation Systems, Power Plant Design with Renewable Energy
Program Outcomes Link(s)	b-D, d-D, g-D
Course Outcomes	After completing this course, the student must be able to: 1. Design and conduct experiments involving performance test, heat balance and efficiency of power plants 2. Design and conduct experiments involving performance test, heat balance and performance test of refrigeration system 3. Perform air-conditioning load calculation 4. 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 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 Computational Laboratory – 1 unit
Number of Contact Hours per week	Lecture - 3 hours Computational Laboratory – 3 hours
Prerequisite Co-requisite:	Air – conditioning and Ventilation Systems Manufacturing and Industrial Processes with Plant Visits
Program Outcomes Link(s)	a-D, c-D, e-D, h-D

Course Outcomes	After completing this course, the student must be able to: 1. Apply basic design concepts to industrial plants systems and equipment. 2. Select system components and equipment in industrial plant. 3. Perform computations and analysis leading to the design of industrial plant facilities. 4. Evaluate the performance of the different industrial plant facilities considering some realistic constraints such as economic, environmental, health and safety, social and ethical.
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 DESIGN WITH RENEWABLE ENERGY**
Course Description	The course deals with the 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. It includes the discussion of renewable energies such as solar, wind, tidal, hydro-electric, bio-mass, OTEC and others.
Number of Units for Lecture and Laboratory	Lecture- 3 units; Computational Laboratory – 1 unit
Number of Contact Hours per week	Lecture- 3 hours; Computational Laboratory – 3 hrs
Prerequisite	Combustion Engineering
Program Outcomes Link(s)	a-D, c-D, e-D, h-D
Course Outcomes	After completing this course, the student must be able to: 1. Identify the components of the different power plants 2. Evaluate the performance of the different power plants 3. Explain the different types of renewable energies 4. Design a simple power plant considering some realistic constraints such as economic, environmental, health and safety, social and ethical
Course Outline	1. Steam Power Plants 2. Variable Load Problems 3. Diesel Electric Power Plants 4. Gas Turbine Power Plants 5. Hydro-electric Power Plants 6. Geothermal Power Plants 7. Combined Cycle Power Plants 8. Renewable Energies: solar, wind, tidal, hydro-electric, bio-mass, OTEC and others. 9. Power Plant Economics 9.1 Various cost components in power generation 9.2 Pie chart analysis & construction 9.3 Plant cost comparison of various types of power plants. 10. Co-generation and Energy Management System
Laboratory Equipment	None

Course Name	**ME LAW, ETHICS, CONTRACT, CODES AND STANDARDS**
Course Description	The course deals with the study of the Mechanical Engineering law, contracts, code of ethics 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 - 2 units
Number of Contact Hours per week	Lecture- 2 hours
Prerequisite	Ethics
Program Outcomes Link(s)	f-E, g-E, j-E
Course Outcomes	After completing this course, the student must be able to: 1. Explain the engineering profession and the requirements for professional practice 2. Resolve ethical dilemmas in the mechanical engineering profession with the use of ethical theories and concepts, and ethical problem solving techniques. 3. Discuss the important and critical provisions of the Mechanical Engineering Law, Philippine Mechanical Engineering Code and Standards. 4. Explain the concept, nature and types of engineering contracts.
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 Issues and case studies in Engineering 6. Local and International Codes and Standards 7. Contracts and Specifications 8. National Building Code of the Philippines
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
Program Outcomes Link(s)	a-E, b-E, c-E, d-E, f-E, g-E, k-E

Course Outcomes	After completing this course, the student must be able to: 1. Prepare a written project study proposal which contains the following: statement of the problem, objective, significance of the study, scope and limitations, related literature, underlying theories and concepts, and methodology 2. Present orally the project study proposal to a panel.
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
Program Outcomes Link(s)	a-D, b-D, c-D, d-D, f-D, g-D, k-D
Course Outcomes	After completing this course, the student must be able to: 1. Prepare a written project study report which contains the following: statement of the problem, objective, significance of the study, scope and limitations, related literature, underlying theories and concepts, methodology, data analysis, presentation of results, conclusions and recommendations. 2. Present orally the project study to a panel.
Course Outline	N/A
Laboratory Equipment	Depending on the project

G. COURSE DESCRIPTION FOR SUGGESTED ELECTIVE COURSES

<u>**Mechatronics Engineering**</u>

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.
to control system;

Automotive Engineering

1. 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.

2. 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.

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

4. 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.

5. 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.

Energy Engineering and Management

1. 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.

2. 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.

3. 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.

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

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. **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.

2. **Indoor Environmental 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.

3. **Design of Building Piping Systems and Air-conditioning Ductworks** – 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. Design and sizing air-conditioning ductworks.

ANNEX IV – Laboratory Requirements for Mechanical Engineering Courses

A. PHYSICAL / NATURAL SCIENCES

CHEMISTRY FOR ENGINEERS

Experiment	Equipment / Chemicals	Quantity
Calorimetry	Thermometer 250 ml Beaker Test Tubes Stirring Rod Filter paper Ice cubes HCl solution NaOH solution NaOH pellets	5 pcs 5 pcs 60 pcs 5 pcs 5 pcs
Heats of Combustion	Bomb calorimeter Fuse wire Solid fuels (*e.g. granulated charcoal, rice husk, sawdust*)	1 pc
Metals and Some Aspects of Corrosion	Petri Dish Test Tubes Graduated cylinder Syringe Stirring Rod Iron Stand and Ring Wire gauze Bunsen Burner Mg ribbon Zn pellets Fe fillings Cu wire Sn shavings Pb pellets Fe nails Agar-agar powder Magnesium Nitrate Zinc Nitrate Iron Natrate Copper Nitrate Lead Nitrate Tin Chloride Potassium Ferrocyante Phenolphthalein	5 pcs 60 pcs 5 pcs 5 pcs 5 pcs 5 pcs 5 pcs 5 pcs
Mechanical Properties of Materials	Universal Testing Machine Metal rods	1 unit 5 pcs
Water: Its Properties and Purification	Bunsen burner Tripod Wire gauze Erlenmeyer Flask Boiling chips Delivery tube	5 pcs 5 pcs 5 pcs 5 pcs 5 pcs

	Cork Beaker Test tubes	5 pcs 5 pcs 5 pcs
Determination of the Dissolved Oxygen Content of Water	Amber Bottles Erlenmeyer Flasks Burette Phenolphthalein Sulfuric acid solution DO meter, if available	10 pcs 5 pcs 5 pcs
Determination of Air Pollutants (e.g. cigarette smoke)	Erlenmeyer Flask Glass Tubing Cork Cotton Pump	5 pcs 5 pcs 5 pcs 2 units

PHYSICS FOR ENGINEERS

SUGGESTED PHYSICS LABORATORY EXERCISES
(Pick 12 to relate with Covered Lecture Topics)

Exercise	Suggested Equipment	Suggested 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 Alternate apparatus: Force frame Spring balance Weight holder Masses Ruler	5 pcs. 20 pcs. 5 sets 5 pcs. 5 pcs. 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	5 pcs. 5 pcs. 5 pcs. 5 pcs. 12 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.

	Clamp Wooden cart Scissors Carbon paper Masking tape Meter stick	5 pcs. 5 pcs. 5 pcs. 5 pcs. 1 set 5 pcs.
	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 String Clamp	5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 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	Metal stand	5 pcs.

the principles of conservation of mechanical energy	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. 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	 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs.

	Thermometer Specimen of solids Alternate apparatus: Mohr-Westpal Balance	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.
15. 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 Ice Water	5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 sets
16. 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.
17. 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.
18. 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
19. 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	5 pcs. 5 pcs. 5 pcs. 5 sets 15 pcs. 5 pcs. 5 pcs.

	Alternate apparatus: Bread board Jumper	 5 pcs. 5 sets
20. 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
21. 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
22. 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
23. 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
24. 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.

25. 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 multi-tester Stopwatch	5 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs.
26. An exercise to observe the principle of magnetic field	Natural magnets Horseshoe magnets Bar magnets 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. 10 pcs. 5 pcs. 5 pcs. 5 sets 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 5 pcs. 2 sets
27. 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.
28. 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.
29. 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.

B. MECHANCIAL ENGINEERING COURSES

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

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

Notes:
1. Woodworking equipment mentioned in item 4 above are optional.
2. Forging and foundry tools, furnace and cupola – crucible type are recommended but optional.

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

Notes:

1. CNC machines, shapers, surface grinder and cylindrical grinders are recommended but optional

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

ME LABORATORY 2

Recommended Experiments/Exercises

1. Performance test and pumps, blowers and compressors
2. Characterization of Fluid Flow
3. Determination of Heat Losses in Heat Exchangers
4. Performance test combustion engines

List of Equipment/Apparatus Required

1. Pumps, blowers, and compressors test rig
2. Diesel Engine Performance test bed
3. Gasoline Engine Performance test bed
4. Reynolds Apparatus

ME LABORATORY 3

Recommended Experiments/Exercises

1. Analysis and Performance Test of Refrigeration System
2. Analysis and Performance test of Air conditioning System
3. Analysis and Performance Test of Steam Power Plant

Laboratory Equipment/Apparatus Required

1. Refrigeration Trainer
2. Air Conditioning Trainer
3. Mini Steam Power Plant

MATERIALS AND ENGINEERING LABORATORY

Recommended Experiments/Exercises

1. Determination of Tensile Strength
2. Determination of Compression Strength
3. Determination of Shear Strength
4. Determination of Flexural Strength
5. Determination of Torsional Shear Strength
6. Determination of Fatigue Strength
7. Determination of Hardness
8. Non – Destructive Tests

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. Non – Destructive Testing Equipment

Note:

1. There must be at least two non – destructive testing equipment

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

Sample Syllabus

Course Title : Thermodynamics 1
Course Description : This course deals 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.
Course Code :
Course Units : 3 units
Pre-requisites : Physics for Engineers, Calculus 2

Course Outcomes and Relationships to Student Outcomes

Course Outcomes	Student Outcomes											
After completing the course, the student must be able to:	a	b	c	d	e	f	g	h	i	j	k	l
1. Identify the different properties of pure substance, ideal gas and real gas	I				I							
2. Apply thermodynamic concepts and principles in analyzing and solving problems.	I				I							
3. Apply the laws of thermodynamics in analyzing problems	I				I							
4. Evaluate the performance of thermodynamic cycles.	I				I							

Note: I = Introductory, E = Enabling, D = Demonstrated

Learning Plan

Week	Course Outcomes	Topics	TLA	AT
1	Course Outcome 1	Introduction to Thermodynamics Scope and definition of Thermodynamics, dimensions and units, thermodynamic systems, thermodynamic processes,	 Lecture Video presentation	

		cycles.		
2	Curse Outcome 2	Basic Concepts, Principles and Definitions	-Lecture -Seatwork	-Problem Set 1 -Exam
3	Course Outcome 3	First Law of Thermodynamics	-Lecture -Class Discussion -Film Showing	- Problem Set -Exam
4	Course Outcome 3	Ideal Gas / Ideal Gas Laws	-Lecture -Film Showing -Boardwork	-Problem Set -Exam
5		EXAM No. 1		
5, 6, 7	Course Outcome 1, 2, 3	Processes of Ideal Gases	-Lecture -Group Problem Solving -Class Discussion -Video	-Problem Set -Exam
7, 8		Properties of Pure Substances	-Lecture -Class Discussion -Reading of tables and charts	-Problem Set -Exam
8, 9, 10		Processes of Pure Substances	-Lecture -Group Problem Solving	-Problem Set -Exam
10		EXAM No. 2		
11, 12		Introduction to cycle analysis: Second Law of Thermodynamics	-Lecture -Class Discussion -Group Problem Solving	-Problem Set -Exam
13, 14		Introduction to Gas and Vapor Cycles	-Lecture -Class Discussion	-Problem Set -Exam
15		EXAM No. 3		
15, 16		Real Gases	-Lecture -Group Problem Solving	- Problem Set -Exam
17		Special Topics in	- Lecture	-Term

		Thermodynamics	-Report -Class Discussion	Paper
18		Final Examination		

Grading System:

Average of 3 Exams - 50%
Final Examination - 30%
Term Paper - 10%
Problem Set - 10%

Passing - 70%

Term Paper will be graded according to the following: (Specify rubric for grading)

	Outstanding	Very Good	Good	Needs Improvement
Content (50%				
Analysis (50%)				

References:

Engineering Thermodynamics by Shapiro and Moran, 7^{th} edition
Thermodynamics by Cengel and Boles
Thermodynamics by Burghardt
Thermodynamics by Faires

On – line Resources:
(include website that will help students understand better the concepts learned)

Course Policies and Standards:
(Include policies regarding deadline of submission of requirements, absences and tardiness in attending classes, missed exams, etc.)