MAKERERE UNIVERSITY

COLLEGE OF ENGINEERING, DESIGN, ART AND TECHNOLOGY (CEDAT)

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

REVISED MASTER OF SCIENCE IN MECHANICAL ENGINEERING

DAY/EVENING PROGRAMME

PROPOSED START DATE: AUGUST 2011

MARCH 2011

1. INTRODUCTION

The Department of Mechanical Engineering has been running graduate programmes since 1996. Currently, the master's degree programmes being offered are Master of Engineering and Master of Science in the fields of Mechanical Engineering. The developments of these two programmes are based on the need from the market. The graduates from these programmes are employed at the top levels of the professional departments of government, established companies and agencies.

There are many bachelors' degree graduates who are working in various institutions and industries in the country. These are generally adequate for the various levels in which they are occupied. However, with the changing working environment and technology, these graduates need to upgrade after several years of working in industry and other institutions. This is highly necessary in Uganda. As the country attracts investment from overseas, newer and modern technologies are brought in the country. It is imperative that there are avenues for upgrading the knowledge and competences of graduates after several years of working and also after running the programmes for some time.

This revised Master of Science in Mechanical Engineering has been developed with the objective of producing graduates capable of understanding, adopting and utilizing technology to produce tangible products and services at affordable costs. It builds on the undergraduate programme. The graduates are expected to pursue PhD after their completion of their study. There are a number of upcoming higher education institutions which need manpower in the area of mechanical engineering up to PhD level. None of these institutions offers a master's degree programme.

This programme will be complemented by other upcoming graduate programmes to be conducted by the department such as Master of Science in Technology Innovation and Industrial Development which is a new programme in the department and will be run in collaboration with the Norwegian counterparts from the Norwegian University of Science and Technology.

2. JUSTIFICATION / RELEVANCE OF THE PROGRAMME

Various pieces of equipment and mechanisms are central to our modern engineering industries. An understanding of their nature continues to be essential for all engineers. There are continuous developments in all areas of engineering leading to new requirements and capabilities of engineers to design, manufacture, operate and maintain such equipment and devices. In this programme, specialisations are introduced in areas of Energy System Engineering and Manufacturing Engineering. There will be some compulsory courses and a reasonable number of electives. More areas of specialisation will be identified in the near future.

In the last five years, the Department of Mechanical Engineering has conducted PhD training, mostly as a joint degree programme. The department has been receiving an increasing number of PhD candidates from other universities. These find it cheaper to train members of staff in Makerere University, since the Department of Mechanical Engineering has a number of associate professors and over seven PhD holders and more members of staff are about to complete their PhDs in different fields within the next two to three year.

Most of the graduates who work in industry are facility managers. As such, energy cost is one of the main concerns in industries. This is the reason the energy option will continue to attract students. In addition, there has been an increasing number of manufacturing industries' investments over the last decade. It is envisaged that this programme will attract these students as well.

3. CHANGES IN THE PROGRAMME

The Department has been running two different programmes which lead to Master's degree in Mechanical Engineering – Master of Engineering (Mechanical), Master of Science in Mechanical Engineering. The following courses were offered for Master of Engineering (Mechanical) and the Master of Science in Mechanical Engineering. The revisions introduced are illustrated in Table 1. Some of the old courses were retained; however there are many new courses introduced to reflect the changing environment in the mechanical engineering field.

Table 1: The Present Graduate Courses

Code	Course Name	Remarks	Code	Course Name	Remarks
TEC7101	Principles of Management	Retained	EMT7101	Computer Application in Engineering	Dropped
MEC7101	Maintenance Engineering	Dropped	ELE7101	Instrumentation and control	Dropped
TEC7201	Business Administration	Dropped	MEC7201	Energy Planning and Management	Retained
MEC7202	Renewable Energy Technology	Modified	MEC7204	Production Engineering	Dropped
MEC7203	Welding Technology	Dropped	MEC7205	Engineering Facture and fatigue	Dropped
TEC7301	Business Administration II	Dropped	TEC7203	Research Methods	modified
MEC7304	Power Plants	Modified	MEC7302	Air conditioning and refrigeration	modified
MEC7303	Heat Exchanger Design	Dropped	MEC7305	Combustion engineering	Dropped
MEC7306	Extractive Metallurgy	Dropped	MEC7307	Plastic Deformation and Metal forming	Dropped
MEC7308	Plastic Engineering	Dropped	MEC7309	Fuel Furnace and refractories	Dropped
MEC7311	Material handling and management	Dropped	MEC7310	Production Planning and Control	Modified
MEC7313	Machine Tool Design	Dropped	MEC7312	Advanced Manufacturing	Dropped
MEC8101	Research and Dissertation	Modified			

The revisions introduced are generally based on the observations that the courses previously offered cut across various areas of specialisation in Mechanical Engineering. Some areas such as energy were not adequately addressed in the programme. It would not be possible to train specialised human resource if the course structure was maintained. Therefore, there was need to change courses and introduce specialities in the programme.

Some of the key changes made arose from the following specific observations:

- The graduate courses could be grouped under the main areas of specialisation such as energy and manufacturing, but there were no clear boundaries. Students were given the options to elect the course they prefer.
- The Research Methods courses should be a first semester course, but was taught in the second semester in some cases.
- There were some courses which were never taught because students did not either have interest in them or the number of students who chose the courses were just too few to form a class. For examples courses entitled: Welding Technology, Plastic Engineering, Plastic Deformation of Materials, Conduction, Convection and Radiation Heat Transfer were not taught for over 10 years.
- There were some courses which were popular. These included: Production Planning and Control, Plant Engineering, and Renewable Energy Technologies.
- There was a lack of clear distinction among the sub-disciplines within the programme. Consequently, the level of research work was just moderate. This was insufficient to propel a graduate to a higher level degrees such as PhD or Doctor of Science

Based on the above arguments, there was need to restructure the programme to match the current need within Uganda and the region as a whole.

4. PROGRAMME GOALS AND OBJECTIVES

4.1 Goals

The goals of the programme are to;

- Produce graduates who can address the energy problems of Uganda and the Africa region.
- Produce graduates who can solve practical problems in the manufacturing and production sector of Uganda and the Africa region.

4.2 Specific Objectives

The specific objectives of the programme are aligned to the specialized sub-disciplines within mechanical engineering that are to be offered.

Energy Systems Engineering

The specific objectives of the programme in this area are to produce creative and innovative graduates who are capable of:

- Managing complex technical and financial projects in utility companies, energy companies and manufacturing companies.
- Designing energy production, transport and storage systems.
- Using sustainable approaches to develop new and clean energy technologies.
- Understanding the complexities of energy technologies, the importance of energy demand, energy usage, energy policy and energy sustainability, and the impact of energy conversion on the environment.
- Analyzing and recommending energy options to policy makers of developing economies.
- Meeting the engineering, economic and environmental challenges facing energy systems in Uganda and in the region.

Manufacturing Engineering
The specific objectives of the programme are to produce graduates who are capable of:

- Developing new products.
- Designing production plants and equipment.
- Managing production processes and manufacturing industries.
- Producing and maintaining quality products.
- Designing and constructing production equipment and products.
- Enhancing competitiveness in manufacturing companies.
- Selecting materials and equipment for the manufacturing and production sector.

5. EMPLOYMENT OPPORTUNITIES
The graduate of the programme will in general find opportunities for employment in the sub-disciplines offered.

Energy Systems Engineering
The graduates of the Energy Systems Engineering specialization shall find jobs in;

- Power production companies as Design and Process Engineers.
- Engineering companies as Project Engineers.
- Energy equipment manufacturing companies as Project Design Engineers.
- Research organizations and consultancy firms as Designers and Developers of new products for energy equipment manufacturers.
- Government Energy Departments as Energy Policy Makers.
- Various organizations where energy conversion occurs as Energy Advisors/ Specialists.
- Chemical and Petroleum processing plants

Manufacturing Engineering
The graduates of the Manufacturing Engineering programme shall find jobs in;

- Manufacturing companies.
- Research and Development Organizations
- Consulting firms
- Government departments
- Sales companies
- Mining sector (material flow system)

6. TARGET GROUP

There is a growing number of private and government universities which need trained manpower. The National Council for Higher Education demands highly qualified members of staff in these institutions. The graduates will no longer have to go outside Uganda for some of the training courses which are offered in the Department of Mechanical Engineering.

The School of Engineering has been attracting graduates from other countries like Mozambique, Ethiopia and Malawi and other neighbouring countries. Most the courses are offered by lecturers who are members of staff from the Department of Mechanical Engineering; mostly in the areas of energy and production engineering.

There is a good number of graduates who have been working in the field for over five years. During the time of their work, they acquire skills. At the same time there are developments in the areas of technology and new courses being taught. Thus the working class of engineers is one of the target groups.

6.1 Mode of Leaning and Teaching

The programme will be conducted through lectures, laboratories, industrial visits, assignments, seminars, project work, and/or research.

7. PROGRAMME IMPLEMENTATION

The M.Sc Mechanical Engineering Program is to be based on two plans namely, Plan A and Plan B, as follows;

Plan A: Coursework and Dissertation

Plan B: Extended Coursework and Project Report

For any student to graduate in this Programme, the following requirements will have to be fulfilled;

a) A student's progression under Plan A is dependent on whether he/she has a Research Proposal by second week of the 3rd Semester.
b) A student's progression under Plan B is dependent on whether he/she has project Proposal by second week of the 4th Semester.
c) The Pass Mark for all Courses shall be 60%.
d) Credited Entrepreneurship Seminar Series conducted by students are mandatory.
e) All Coursework for this Programmes are examined externally.
f) The Title of the Dissertation/Project Report appears on the Academic Transcript with respective grades indicated.
g) The Dissertation is in Partial Fulfilment of the Degree.

7.1 Plan A: Coursework and dissertation

a) A student on this Plan must complete an approved program of Coursework consisting of a minimum of 15 Credit Units during the year.
b) A student must submit a Dissertation.
c) A Dissertation carries a credit 10 Credit Units per Semester. External examination of Dissertation is mandatory.
d) Seminar Series are mandatory for all registered students.
e) Departments will select topics for students and that a student is required to make presentations during the Seminars Series.
f) The minimum Graduation load is 60 Credit Units.

7.2 Plan B: Course work and project field report

a) A student on Plan B must complete an approved programme of Coursework that constitutes 75% of the entire workload for the Degree.
b) A student must submit a Report on a supervised Short Project/Field , preferable where he/she works or employed

c) Seminar Series are mandatory for all registered students and are conducted every Semester of the second year. The Seminar Series have 10 Credit Units per Semester.
d) External examinations of Projects/Reports are mandatory
e) The student graduating will be able to continue to PhD if the takes prerequisite courses.

8. LEARNING OUTCOMES

- The graduate will form the core of researchers and assistant lecturers in the universities and other research institutions. A number of graduates will proceed to the PhD programme.
- M.Sc. graduates will be working in management and industrial sectors as supervisors and production managers in industries and other manufacturing sectors.
- The graduates who take the energy option will be employed in ministries as energy officers or energy engineers and managers in industrial establishments.
- The graduate will facilitate the speed and cost-effectiveness of technology transfer from research and development, and development of improved production techniques in their work places.

9. NATURE OF THE PROGRAMME

This is a day/evening programme that is completely privately sponsored with duration of a minimum of one year and a maximum of four years. Students in the programme can follow one of two study options- Plan A or Plan B.

10. ADMISSION REQUIREMENTS

To qualify for admission for Master's Degree Programmes, the candidate must hold a Bachelor's degree in engineering in a scientific or technological field. All other admission requirements and regulations of Makerere University shall apply.

- An applicant must be a holder of at least a Second Class degree or its equivalent awarded by Makerere University or any other recognized institution.
- An applicant who is a holder of a third class degree or its equivalent may be admitted only after providing evidence of academic growth and maturity in the desired field of study as judged by the Board of Graduate Studies and Research.

10.1 Prerequisite courses:

A candidate who graduates under plan B and would like to proceed to PhD, will be required to undertake remedial course. In the energy systems engineering option, these will be:

- Two phase flow and Heat Transfer
- Convectional Power Generation

11. SPECIFIC REGULATIONS FOR THE OPTIONS

There will be two specializations running under M.Sc. Mechanical Engineering, namely Energy Systems Engineering and Manufacturing Engineering.

11.1 Energy Systems Engineering

PLAN A: **Programme Structure**

Table 2: Programme for Courses in Semester I

Semester I 5 courses (four compulsory one elective)						
Core Courses (Compulsory)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
RET7105	Statistics and Research Methods	40	0	10	45	3
MEC7105	Principles of Management	45	0	0	45	3
MEC7106	Thermo-chemical Energy Engineering	35	10	10	45	3
MEC7107	Measurement Techniques in Engineering	30	15	15	45	3
Elective (Student Selects Only one Course)						
MEC7108	Hydropower Systems	30	15	15	45	3
MEC7109	Two Phase flow and Heat Transfer	35	10	10	45	3
MEC7110	Solar Energy Technology	30	15	15	45	3

Table 3: Programme for Courses in Semester II

Semester II 5 courses (four compulsory one elective)						
Core Courses (Compulsory)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
EMT7201	Advanced Engineering Mathematics	30	0	15	45	3
RET 7203	Project Management	45	0	0	45	3
MEC7229	Conventional Power Generation	35	10	10	45	3
MEC7230	Numerical Methods in Energy Engineering	40	0	10	45	3
Elective (Student Select Only one Course)						
MEC7231	Energy Management	35	10	10	45	3
MEC7232	Other Alternative Energy Resources	35	10	10	45	3
MEC7233	Modelling and Simulation of Energy Technology	40	0	10	45	3

Table 4 : Semester III and Semester IV

Semester III						
Core Courses (Compulsory)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
MEC8100	Dissertation	0	200	0	150	10
MEC8101	Research Seminar I	0	60	0	30	2
Semester IV						
MEC8201	Research Seminar II	0	60	0	30	2

PLAN B : Programme Structure

Table 5 : Programme for Courses in Semester I

Semester I 5 courses (four compulsory one elective)						
Core Courses (Four Compulsory, One Elective)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
RET7105	Statistics and Research Methods	40	0	10	45	3
MEC7105	Principles of Management	45	0	0	45	3
MEC7107	Measurement Techniques in Energy Engineering	30	15	15	45	3
MEC7106	Thermo-chemical Energy Engineering	35	10	10	45	3
Elective (Student Select Only one Course)						
MEC7108	Hydropower Systems	30	15	15	45	3
MEC7110	Solar Energy Technology	30	15	15	45	3
MEC7111	Biochemical Engineering	35	10	10	45	3

Table 6: Programme for Courses in Semester II

Semester II 4 courses (Four compulsory one elective)						
Core Courses (Compulsory)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
EMT7201	Advanced Engineering Mathematics	30	0	15	45	3
RET7203	Project Management	0	0	0	0	3
MEC7230	Numerical Methods in Energy Engineering	40	0	10	45	3
MEC7229	Conventional Power Generation	35	10	10	45	3
Elective (Student Selects Only one course)						
MEC7231	Energy Management	35	10	10	45	3
MEC7232	Other Alternative Energy Resources	35	10	10	45	3
MEC7233	Modelling and Simulation of Energy Technology	40	0	10	45	3

Table 7: Programme for Courses in Semester III and IV

Semester III Four courses (Three Compulsory, one Elective)						
Core Courses Three Courses						
Code	**Course Name**	LH	PH	TH	CH	CU
MEC8101	Seminar	0	30	0	30	2
MEC8102	Impact of Energy Generation on Environment	40	0	10	45	3
TID8102	Safety, Health & Environment Management	45	0	0	45	3
Electives (Student Selects one course)						
MEC7109	Two Phase flow and Heat Transfer	35	10	10	45	3
MEC8103	Advanced Heating, Refrigeration and air-conditioning	40	0	10	45	3
Semester IV One Course Compulsory						
MEC8200	Research Project and report	0	150	0	75	5

11. 2 MANUFACTURING ENGINEERING

PLAN A **Programme Structure**

Table 8 : Programme for Courses in Semester I

Semester I 5 courses (three compulsory and two elective)						
Core Courses (Compulsory)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
MEC7105	Principles of Management	45	0	0	45	3
MEC7112	Manufacturing Processes and Product Quality Control	45	0	0	45	3
RET7105	Statistics and Research Methods	45	0	0	45	3
Elective (Student Select Only two Courses)						
MEC7113	Business and Operations Strategy	45	0	0	45	3
MEC7114	Energy management	45	0	0	45	3
MEC7115	Computer Aided Manufacturing	34	52	0	60	3
MEC7116	Applied Linear Algebra	45	0	0	45	3

Table 9 : Programme for Courses in Semester II

Semester I Five courses (Three compulsory two elective)						
Core Courses (Compulsory)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
EMT7201	Advanced Engineering Mathematics	45	0	0	45	3
RET7203	Project Management	45	0	0	45	3
MEC7234	Manufacturing Modelling and	45	0	0	45	3

	Analysis					
Elective (Student Select Only two Courses)						
MEC7236	Advanced Manufacturing Materials	30	30	0	45	3
MEC7237	Asset Management	45	0	0	45	3
MEC7238	Automation	30	30	0	45	3
TID7202	Logistics Engineering	45	0	0	45	3

Table 10 : Programme for Courses in Semester III and Semester IV

Semester III						
Core Courses (Compulsory)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
MEC8100	Dissertation	0	200	0	150	10
MEC8101	Research Seminar I	0	60	0	30	2
Semester IV						
MEC8201	Research Seminar II	0	60	0	30	2

PLAN B **Programme Structure**

Table 11: Programme for Courses in Semester I

Semester I 5 courses (three compulsory and two elective)						
Core Courses (Compulsory)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
MEC7105	Principles of Management	45	0	0	45	3
MEC7112	Manufacturing Processes and Product Quality Control	45	0	0	45	3
RET7105	Statistics and Research Methods	45	0	0	45	3
Elective (Student Select Only two Courses)						
MEC7113	Business and Operations Strategy	45	0	0	45	3
MEC7114	Energy management	45	0	0	45	3
MEC7115	Computer Aided Manufacturing	34	52	0	60	3
MEC7116	Applied Linear Algebra	45	0	0	45	3

Table 12 : Programme for Courses in Semester II

Semester I Five courses (Three compulsory, two elective)						
Core Courses (Compulsory)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
EMT7201	Advanced Engineering Mathematics	45	0	0	45	3
RET7203	Project Management	45	0	0	45	3
MEC7235	Manufacturing Modelling and Analysis	45	0	0	45	3
Elective (Student Select Only two Courses)						
MEC7236	Advanced Manufacturing Materials	30	30	0	45	3
MEC7237	Asset Management	45	0	0	45	3

MEC7238	Automation	30	30	0	45	3
TID7202	Logistics Engineering	45	0	0	45	3

Table 13 Programme for Courses in Semester III and Semester IV

Semester I Three Courses (Two compulsory one elective)						
Core Courses (Compulsory)						
Code	**Course Name**	**LH**	**PH**	**TH**	**CH**	**CU**
MEC8101	Seminar	0	30	0	30	2
TID8102	Safety, Health & Environment Management	45	0	0	45	3
Elective (Student Select Only one Course)						
TID8104	Life-Cycle Analysis and Sustainability	45	0	0	45	3
TID8105	Advanced Product Design and Development	45	0	0	45	3
Semester IV						
One Core course						
MEC8200	Research Project and report	0	150	0	75	5

The total unit for student to graduate are 60.

LH- lecture hour, TH - tutorial hour, PH- practical hour, CH -Contact hour, CU- credit unit

12. DETAILED COURSE CONTENTS

There are some courses which are common in this programme, while others are specialised courses.

RET7105: Statistics and Research Methods

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
35	0	20	45	100	60	40	3

Course Description

This course presents the fundamentals, concepts and methods used in the analysis of data. It covers definitions, methods of computation of the various measures of data summarization. The course will also cover advanced engineering research skills, focusing on research design, design of data collection instruments, implementation of data collection plans, and principles of research report writing and dissemination.

The Course Objectives

The aims of this course are to:

- Provide students with a strong knowledge base for mathematical analysis of energy systems.
- Equip students with background and fundamental knowledge behind the techniques for analyzing a vast amount of data for different scenarios with ease
- Equip students with the skills to use the tools for handling large amounts of data Explain to students the role of research in knowledge creation
- Instruct students on how research is conducted practically and in academic circles

Learning Outcomes

At the end of this course, a student should be able to:

- Explain the mathematical concepts of data occurrence and analysis
- Apply the different methods of displaying and reporting data
- Compute the various quantities used to summarize data
- Distinguish among the different scenarios of occurrence of events
- To test different data sets to find which models best describe them
- Explain the various terminology used in research methods
- Describe the various research designs applied in research
- Develop a research proposal including identification of a research problem, formulation of research objectives, description of the methodology and the data analysis techniques
- Identify shortcoming in research proposals, designs and reports

Detailed Course Content

1. Research Methods

1.1 Introduction **(2 Hours)**

- Definition of Research
- Role of Research in the Engineering Profession
- Types of Research (Basic Vs Applied; Primary Vs Secondary; Exploratory Vs Constructive Vs Empirical)
- Research Processes (The Scientific Vs Historical Research Process)
- Information Literacy Strategies
- Research Funding
- Research and Publishing

1.2 Elements of General Academic Writing **(3 Hours)**

- The Writing Process (Invention, Composition and Revision)
- Research Concept Note (Synopsis)
- Proposal
- Thesis Report
- Papers
- Abstracts
- Formatting Style (MLA Vs APA)

1.3 Identifying and Formulating a Research Problem **(2 Hours)**

- Definition of Research Problem
- Identify a Research Problem (Sources of Research Problems)
- Testing the Feasibility of the Research Problem
- Formulating a Research Problem
- Statement of the Problem
- Components of a Problem Statement

1.4 Developing Other Proposal Components **(6 Hours)**

- Formulating a Research Title
- Formulating and Stating the Research Objectives
- Stating the Research Justification
- Literature Review
- The Research Methodology
- The Research Resources Plan (Work plan, and Budget)
- References and Bibliography
- Appendices
- Pagination of Research Proposal

1.5 Research Ethics **(6 Hours)**

- Intellectual Property Rights (Makerere IPM Policy and other International IPM Policies)
- Research Ownership and Mandate of Researcher
- Research and Citations (Notation and Standards)
- Plagiarism (Definition, manifestation, and consequences)
- Authenticity of Facts and Opinions (Proper Research Language and avoiding weasel word and fallacies)
- Rights of Human and Animal Survey Respondents

1.6 Data Collections and Analysis **(6 Hours)**

- Designing and Executing a Survey
- Sources of Data
- Sample and Populations
- Sampling Methods
- Quantitative and Qualitative Approaches
- Data Collections Instruments and Methods, their Context and Limitations (Questionnaires Vs Interview Vs Check Lists)
- Questionnaire Design: Types of Questions, Response Rate and Sample Size
- Coding Data: Missing Values, Open Ended Questions

1.7 Research Designing **(2 Hours)**

- Choosing an Operational Definition
- Experimental and Non-Experimental Designs
- Internal and External Validity and Associated Threats
- Groups Vs Repeated Measure Design

1.8 Presentation of Research **(1 Hour)**

- Oral Presentation (Proposal and Viva Voce)
- Use of Presentation Aides
- Use of Graphics and Animations in Presenting Research
- Presentation Language

2. Statistics and Data Analysis

2.1 Introduction **(2 Hours)**

- Definition of Statistics
- Role of Statistics in Engineering Research
- Misuse and Abuse of Statistics
- Data Measurement

2.2 Descriptive Statistics **(5 Hours)**

- Introduction
- Frequency Distributions: Histograms and bar charts, The shape of a distribution, Determining if skewness and kurtosis are significantly non-normal
- Central Tendency: Measures of central tendency, Choosing a measure of central tendency
- Variability: Sums of squares, Variance, Standard deviation
- The Normal Distribution
- Transformations: Dichotomisation, Z-scores, The standard normal distribution, Normalising
- Correlation and Regression
- Descriptive Statistics Using Data Analysis Software

2.3 Inferential Statistics **(5 Hours)**

- Introduction
- Null and alternative hypotheses
- Hypothesis testing
- Type I and Type II Errors
- Analysis of Variance (ANOVA)
- Inferential Statistics using Data Analysis Software

Delivery Method

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Assessment Method

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical/project Work 25%.

Reading List/References

1. John W. Creswell, (2006). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage Publications, Inc; 3rd Edition. ISBN-10: 1412965578, ISBN-13: 978-1412965576
2. Donald H. McBurney and Theresa L. White, (2006). Research Methods, Wadsworth Publishing; 7 Edition. ISBN-10: 0495092088, ISBN-13: 978-0495092087
3. Anthony M. Graziano and Michael L. Raulin (2006). Research Methods: A Process of Inquiry. Allyn & Bacon; 6 Edition. ISBN-10: 0205484751, ISBN-13: 978-0205484751
4. Kenneth Bordens and Bruce Barrington Abbott, (2007). Research Design and Methods: A Process Approach. McGraw-Hill Humanities/Social Sciences/Languages; 7 Edition. ISBN-10: 0073129062, ISBN-13: 978-0073129068
5. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Cole Publishing Company, Latest edition
6. Patrick Neil & Steve Chapman, "Research Methods", 3rd Edition, Poutledge Taylor & Francis Group, 1985
7. Brenda Laurel (ed.), "Design Research; Methods and Perspecitves", MIT Press, 2004

MEC7105: Principles of Management

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
45	0	0	45	100	60	40	3

Course Description:

This course will enable students to develop short and long-range plans to effectively accomplish organizational goals. Through the use of terminology, exercises and case studies, students will be able to give a critical appraisal of real life situations involving organizing, staffing and motivating others. The student will also learn tools to aid in problem solving, valuing diversity and coping with change. The principles learned in this course will allow the student to effectively work with and through others in an organization. Both principles and practices of management as an academic discipline as well as a profession are surveyed, examined, and reviewed. The course focuses on the fundamentals of the practice of management, including administrative, organizational and behavioural theories. It explores the functions of management and the aspects of the organizational environment.

Course Objectives

- To understand the roles and functions of managers at various (entry, middle and the top) levels
- To explain the relationships between organizational mission, goals, and objectives
- To comprehend the significance and necessity of managing stakeholders
- To conceptualize how internal and external environment shape organizations and their responses
- To demonstrate empirical understanding of various organizational processes and behaviours and the theories associated with them
- To demonstrate critical thinking skills in identifying ethical, global, and diversity issues in planning, organizing, controlling and leading functions of management
- To understand organizational design and structural issues

Learning Outcomes

On completion of this course the students should be able to:

- Describe the functions of management.
- Outline the historical theories relating to modern management.
- Explain the role of management within a business setting.
- Describe human resource planning and staffing processes needed to achieve optimal performance
- Prepare a business forecast and budget
- Illustrate how business ethics and social responsibility apply to organizations
- Describe formal and informal organizational communication processes and how to influence employees

Detailed Course Content:

Historical Perspectives of Management: **(6 Hours)**

- The behavioural approach to management
- The management science approach
- The contingency approach
- The system approach

Principles of Planning **(5 Hours)**

- Defining planning, Purposes of planning,
- Advantages and potential disadvantages of planning,
- Management by objectives, Planning tools,
- Strategic planning, Forecasting and budgeting

The Management Task **(6 Hours)**

- The Role of management,
- Defining management,
- The management process, management functions,
- Management goal attainment,
- Management and organizational resources

Fundamentals of Organizing **(5 Hours)**

- The definition of organizing
- The organizing process
- The organizing subsystem
- Classical organizing theory

Leadership and Effective Communication **(6Hours)**

- Defining leadership; leader vs. manager,
- Leadership behaviours, Transformational Leadership,
- Coaching, Entrepreneurial leadership

Controlling for Productivity **(5 Hours)**

- Defining production and productivity,
- Quality and productivity, Operations management,
- Operations control, Using control tools to control organizations

Managerial Ethics and Social Responsibility **(6 Hours)**

- Fundamentals of social responsibility,
- Areas of corporate social responsibility,
- Social responsiveness and decision making,
- Influencing individuals performing social responsibility activities,
- A definition of ethics, Creating an ethical workplace

Making Good Business Decision **(6 Hours)**

- Types of decisions, Elements of the decision situation,
- The decision making process, Decision making conditions,
- Decision making tools, Processes for making group decisions

Mode of delivery

This course will be delivered through lectures, tutorials, exercises, field visits and group projects aimed at solving real life problems.

Method of Assessment

Students will be assessed through assignments, tests, practical work and projects which make up the course work and a final exam at the end of the course as follows:

Course work	40%
Final Exam	60%
Total Mark	100%

Reference Books

[1] Charles W. L. Hill and Steven McShane (2006) Principles of Management. McGraw-Hill/Irwin; 1st Edition. **ISBN-10:** 0073530123, **ISBN-13:** 978-0073530123

[2] Gary Dessler(2003). Management: Principles and Practices for Tomorrow's Leaders, Prentice Hall; 3rd Edition. ISBN-10: 0131009923, ISBN-13: 978-0131009929

[3] Ellen A. Benowitz(2001). Principles of Management. Cliffs Notes. **ISBN-10:** 076456384X, **ISBN-13:** 978-0764563843

[4] Griffin, Ricky W., Management seventh edition, Houghton Mifflin Company

MEC7109: Two Phase Flow and Heat Transfer

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
35	10	10	45	100	60	40	3

Course Description:

This course is directed toward teaching the student about physical phenomena and specific models that can be used as an aid in understanding two phase flow and heat transfer. These physical processes can occur during plant operation and therefore are needed for the design and analysis of the combustion systems, nuclear and other reactors, and heat transfer industrial processes commonly found in plants.

Course Objectives:

The objectives of this course are to:

- Introduce and describe the processes in internal two-phase flows as well as spray formation and the interaction of sprays with solid surfaces.
- Understand and model the behavior of two-phase thermal-hydraulic system components.

Learning Outcomes

At the end of this course, the student should be able to:

- Demonstrate the ability to model multiphase flows
- Perform fundamental analysis of multiphase flow system
- Demonstrate linkage between mass transfer and heat flow

Detailed Course Content:

1. Introduction (3 Hours)

- Fundamentals of heat and mass transfer
- Generating phase diagrams in Engineering Equation Solver (EES) software
- Introduction to mass transport
- Gas-Liquid interfacial phenomena
- Interfacial waves on thin films, jets, jet breakup and bubble growth

2. Two-phase mixtures (5 Hours)

- Particles and films, Homogeneous vs. separated flow model
- Two-phase flow regimes
- Two-phase modeling – one-dimensional
- Flow regime-based pressure drop prediction
- Two-phase modeling – multi-dimensional

3. Drift Flux Model **(5 Hours)**

- Drift Flux model and void fraction prediction
- Flow regimes and interfacial area
- Pressure drop comparison of macro- and micro-scale heat exchangers
- Two-phase flow in small passages

4. **Nucleate boiling** **(5 Hours)**

- Electronics cooling via immersion
- Film boiling
- Flow boiling
- Flow regime-based heat transfer model
- Flow regimes and impact on flow boiling

5. CHF and post-CHF heat transfer **(6 Hours)**

- Analysis of the physical basis for CHF hypotheses
- Flow boiling in small passages
- CHF in small passages
- Two-phase microchannel cold plate for electronics thermal management

6. Fundamentals of condensation **(3 Hours)**

- Internal flow condensation
- The original Carrier Air Conditioner
- Condensation on jets and droplets
- Choking in two-phase flow

7. Efervescent atomizer **(8 Hours)**

- Critical two-phase flow models
- Spray formation and Spray evaporation rate
- Single droplet behavior
- Instabilities - droplet breakup Atomization of the jet in cross-flow
- Instabilities - droplet breakup
- Spray/Wall impingement Spray cooling thermal management of high heat flux sources
- Spray/wall impingement

Mode of delivery

This course will be delivered through lectures, tutorials, exercises, field visits and group projects aimed at solving real life problems.

Laboratory

Boilers and Heat Exchangers **(10 Hours)**

Method of Assessment

Students will be assessed through assignments, tests, practical work and projects which make up the course work and a final exam at the end of the course as follows:

Course work	40%
Final Exam	60%
Total Mark	100%

Reference Textbooks

[1] Mostafa Ghiaasiaan S. (2008), Two-Phase Flow, Boiling, and Condensation 1st Edition, Cambridge University Press, Cambridge. **ISBN-10:** 0521882761

[2] Nellis G. F. and Klein S. A. (2008). *Heat Transfer 1st Edition*, Cambridge University Press, Cambridge, **ISBN-13:** 978-0521881074

[3] P B Whalley (2008). *Two-Phase flow and heat transfer***,** Atlantic **ISBN:** 0198564449

[4] John G Collier (1999). *Two- Phase Flow and Heat Transfer in the Power and Process Industries* McGraw-Hill Companies ISBN: 0070049025 EAN: 9780070049024

MEC7107: Measurement Techniques in Energy Engineering

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
30	15	15	45	100	60	40	3

Course Description:

This course focuses on developments of measurements in thermal systems. Such systems are complex, expensive and polluting. It is therefore important to be able to determine their performance and their efficiency, since thermal systems enter our daily life directly through generation of electricity, Heating, Ventilation and Air-Conditioning and Transport, and indirectly through chemical processes such as fabricating materials for daily use. Without measurements, scientific models and theories cannot be rigorously tested or challenged hence implying that they are indispensible.

Course Objective:

Energy systems have had numerous developments over the years. Large computers allow increasing number of areas to be numerically simulated. For this case numerical models and simulations need to be verified and experiments are necessary. Since many systems and components involve physics which is not known in detail, this course is intended to study experimental investigations and empirical models while focusing on the main measurement lines in thermal systems such as Research and Development, Acceptance tests and monitoring and diagnostics.

At the end of this course, the student should be able to:

- Describe the role of measurement in thermal systems' studies
- Describe the various techniques used and compare their performance measures

- Specify in detail the various methods available for measuring key thermal system characteristics
- Explain and carry out the methods used for analysis of experimental data
- Plan, execute and satisfactorily report experimental measurements of thermal systems characteristics

Course Learning Outcome:

The goal of the course is that the students should appreciate the role of measurements in testing or challenging scientific models and theories.

Course Outline:

General introduction to measurement techniques in Thermal Fluid systems: **(4 Hours)**

- The nature of measurements
- Types of Measurements,
- Measurement as a Process,
- Measurement as a relation, the elements of a Measuring process,
- Sources of Variability in Measurement,
- Scales of Measurement

Introduce different techniques: **(3Hours)**

- Risk analysis, Introduction to risk analysis,
- key objectives risk management process

Evaluate available methods for a specific application: **(8 Hours)**

- Pressure measurements, pressure transducers,
- High accuracy multi-channel system, averaging,
- Dynamic characteristics, static and dynamic calibration,
- Temperature measurements,
- Methods for Temperature Measurement, Calibration,
- Thermal conductivity, Viscosity, Calorimetry,
- Surface tension, Heat flux, Density of fluids. Flow measurements.

Uncertainty estimation of measured data: **(8 Hours)**

- Data Reduction and Associated Experimental Uncertainty,
- Error analysis, uncertainty of functions,
- Uncertainty of measurements, uncertainty of correlated input,
- Basic data reduction, Type A and B uncertainty,
- Confidence intervals, least square method regression analysis,
- General considerations in data analysis.

Planning experiments: **(4 Hours)**

- Preliminary, intermediate and final stages of an experimental program,
- experimental log book, experimental reports,
- report check list, similarity and analogy, case studies

Reporting experiments **(3 Hours)**

Hands-on experiments **(15 hours)**

Delivery Methods

Include formal lectures (including those from Visiting Lecturers), case studies, tutorial exercises, practical demonstrations, directed learning and individual work

Assessment

The method of assessment is by written examination and evaluation from case studies, Home Assignments and Laboratory Exercises as course work. The Course work takes (40%) and Final Exam takes (60%).

References

1. Holman J.P ,(2001) Experimental Methods for Engineers 7ed., McGraw-Hill, ISBN 0-07-118165-2
2. Taylor B.N., Kuyatt C.E.,(1994), Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results, NIST Technical Note 1297, 1994ed.
3. KirkupL., Frenkel B. (2006) An introduction to Uncertainty in Measurements Using the GUM, ISBN 0-521-60579-2
4. Taylor J.R.(2001) An Introduction to Error Analysis. The study of uncertainties in physical measurements, 2ed, ISBN 0-935702-75-X
5. Coleman H.W., Steele W.G.(1998), Experimentation and Uncertainty Analysis for Engineers, 2ed, ISBN 0-471-12146-0
6. Bevington P.R., Robinson D.K.(2004), Data Reduction and Error Analysis for the physical science, 3ed, ISBN 0-07-247227-8
7. Rabinovich S.G.(2003), Measurement Errors and Uncertainties –Theory and practice, 3ed, ISBN 0-387-25358-0–Lee T.-W., Thermal and Flow Measurements, ISBN 978-0-8493-7970-3
8. Webster J.G., et al.,(1995) Mechanical Variables Measurement –Solid, Fluid, and Thermal, CRC Press, ISBN 0-8493-0047-9 ISO, Guide to the expression of uncertainty in measurement (GUM), corrected and reprinted, ISBN 92-67-10188-9

MEC7108: Hydropower Systems

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
35	10	10	45	100	60	40	3

Course Description

The course covers concepts of hydropower systems including pico, mini, small and large scale plants. It gives a general overview on types of hydropower plants, planning, assessment of hydropower resources, dam design, mechanical and electrical equipment, economic analysis of hydropower plant and the environmental impacts.

Course Objectives

The objectives of this course are to:

- Enable the students appreciate the components of a hydropower systems
- Enable the students understand the procedures for design of hydropower plants and how to carry out hydropower resource assessment.
- Introduce the students to the economic analyses of hydropower projects
- Introduce the students to the aspects of hydropower environmental aspects and how they can be abated

Learning Outcomes

At the end of this course, the student should be able to:

- Describe the theory of operation of hydro energy sources and how they produce energy.
- Explain how the various tools and procedures are used in the design and analysis of power plants
- Compute key characteristics of a small hydropower scheme given basic data
- Explain the effects of hydro energy on the current world energy situation.
- Communicate effectively with both lay and technical audiences about the challenges and opportunities of a Hydro-based economy.

Detailed course Content

Introduction to Hydropower **(3 Hours)**

- Potential and developed hydropower resources
- World hydropower usage
- Hydropower resource in Uganda
- Categorization of hydropower plants

Hydropower Planning **(9 Hours)**

- Hydrologic cycle
- Data acquisition
- Rainfall and discharge measurements
- Flow duration curves, Power duration curves, firm power
- Annual Energy production

Hydropower components **(8 Hours)**

- Dams; construction and types
- Mechanical components design and selection
- Electrical components
- Civil works

Economics of Hydropower plants **(6 Hours)**

- Power markets, regional power pools
- Economic and Financial analysis
- Production and operating strategy

Impacts of Hydro power plants **(3 Hours)**

- Environmental aspects
- Ecological and Social impacts

Software and preliminary design **(6 Hours)**

- Introduction to relevant software for hydropower design

Practical: Turbine – pump efficiency determination, Impulse of a jet on surfaces, Surge tank transients **(10 Hours)**

Mode of delivery

This course will be delivered through lectures, tutorials, exercises, field visits and group projects aimed at solving real life problems.

Method of Assessment

Students will be assessed through assignments, tests, practical work and projects which make up the course work and a final exam at the end of the course as follows:

Course work	40%
Final Exam	60%
Total Mark	100%

Reference Textbooks

[1] Annund Killingtveit, Nils R. Saalthum (1998*). Hydrology for Hydropower Development* Series No. 7, NTNU Hydraulic Engineering division.

[2] Peter L. Payne, (1988) *The Hydro*, Aberdeen University Press (ISBN 0-08-036584-1)

[3] Gulliver J.S., and Arndt R.E.A. (1991) *Hydropower Engineering Handbook*, McGraw Hill Inc. 1991 ISBN. 0-07-025193-2

[4] Linsley R.K et al. (1998). *Hydrology for Engineers*, McGraw Hill Co.

MEC7106: Thermo-chemical Energy Engineering

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
30	15	15	45	100	60	40	3

Course description:

This course covers alternative and renewable fuels derived from biological sources and their applications as an energy source for homes, industry and transportation. Wood, urban and agricultural solid waste are discussed as potential sources of energy. Furthermore, knowledge of relevant fundamental aspects connected to the utilization of biomass and the biomass fractions of waste streams for energy purposes in thermo-chemical conversion processes are presented. The major areas are: combustion, gasification, pyrolysis and liquefaction of biofuels. The economic and environmental aspects of thermo chemical processes including energy efficiency, costs and environmental impact assessments, will be analyzed. Future prospects of bio-fuels and bio-energy including both advantages and disadvantages of Bio-fuels as an energy source.

Course Objectives:

The aims of this course are to:

- Give students a background for understanding thermo chemical processes
- Provide students with in-depth knowledge of the relevant fundamental aspects connected to the utilization of biomass.
- Expose the students to practical application of bioenergy conversion systems

Course Learning Outcomes:

Upon completion of the course, the student will be able to:

- Communicate effectively with both lay and technical audiences about the challenges and opportunities of a bio-based economy.
- The students have gained core knowledge on advanced thermo-thermal processes
- Describe the theory of operation of the different types of bio-fuels energy sources and how they produce energy.

- The students are in position to carry out advanced analysis of real problems in thermal applications
- Demonstrate recommended applications of various commercially available bio-fuels energy technologies.

Course Outline

Biomass Formation **(2 Hours)**

- Biomass resources: Classification and characteristics;
- Techniques for biomass assessment;
- Application of remote sensing in forest assessment; Biomass estimation

Fundamentals of combustion **(3 Hours)**

- Introduction to applied combustion and enthalpy
- Combustion of fuel (solid, liquid and gas)

Thermo-chemical Conversion **(4 Hours)**

- Different processes: Direct combustion, incineration, pyrolysis, gasification and liquefaction;
- Economics of thermo-chemical conversion

Solid Waste **(3 Hours)**

- Definitions: Sources, types, compositions; Properties of Solid Waste; Municipal Solid Waste:
- Physical, chemical and biological property; Collection, transfer stations; Waste minimization and recycling of municipal waste

Energy Generation from Waste **(6 Hours)**

- Thermo-chemical conversion: Sources of energy generation, Gasification; Types of gasifiers; Briquetting; Industrial applications of gasifiers;

- Utilization and advantages of briquetting; Environment benefits of thermo-chemical conversion

Pyrolysis **(6 Hours)**

- Fundamentals
- Feed materials
- Fast and conventional pyrolysis processes,
- Charcoal production
- Pyrolysis kinetics
- Applications of pyrolysis and environmental aspects

Power generation **(6 Hours)**

- Utilisation of gasifier for electricity generation; Operation of spark ignition and compression ignition engine with wood gas ;
- Biomass integrated gasification/combined cycles systems. Sustainable co-firing of biomass with coal;
- Biomass productivity: Energy plantation and power programme.

Delivery Methods

- Lectures, exercises, laboratory work, assignment, study visits

Laboratory: **(10 Hours)**

- Experimental Study on thermal performance and efficiency of biomass downdraft gasifier and sampling and analysis of air and flue gas from biomass energy system (gasifier, combustor and cook stoves using as chromatography technique)
- Biogas production by anaerobic digestion and analysis
- Fuels: density, viscosity, flash-point, fire point, pour-point, ASTM distillation of liquid fuels
- Proximate and ultimate analysis, calorific value of solid fuels

Method of Assessment

- Written exam, laboratory reports, written assignment, and seminars

References

1. Donald L. Klass, “Biomass for Renewable Energy, Fuels, and Chemicals”, Academic Press, 1998, ISBN-13: 978-0-12-410950-6, ISNB-10: 0-12-410950-0
2. Stephen R. Turns, “An Introduction to Combustion: Concepts and Application”, 2nd Edition, McGraw-Hill, 2006, ISNB: 978-007-126072-5
3. David Boyles, “Bio Energy Technology Thermodynamics and costs”, Ellis Hoknood, Chichester, 1984
4. Parker, Colin, & Roberts, “Energy from Waste - An Evaluation of Conversion Technologies”, Elsevier Applied Science, London, 1985
5. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000
6. Rich, Gerald et.al., “Hazardous Waste Management Technology”, Podvan Publishers, 1987
7. Bhide AD., Sundaresan BB, “Solid Waste Management in Developing Countries”, INSDOC, New Delhi,1983.

8. P. Quaak, H. Knoef, H. Stassen, Energy from Biomass, A review of Combustion and Gasification Technologies, World Bank technical paper No 422 Energy Series

MEC7111: Biochemical Energy Engineering

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
35	10	10	45	100	60	40	3

Course description:

The production of methane and alcohol-based fuels and their roles as a transportation fuel will lead to a re-discovery of opportunities to replace fossil-based fuels. Bio-diesel and vegetable oil topics are necessary to show a true alternate energy source for internal combustion engines. Throughout this course, students will examine advanced energy conversion technologies and bio-systems. The course gives a further in-depth knowledge of relevant fundamental aspects connected to the utilization of biomass and the biomass fractions of waste streams for energy purposes in biochemical conversion processes for production of 1st and 2nd generation biofuels.

Course objectives

The aim of this course is to:

- Empower the student with in-depth knowledge of how to obtain bioenergy by means of biochemical processes using different resources.

Learning Outcomes

At the end of the course the student should be able to;

- Describe the theory of operation of the different types of bio-chemical conversion process and how they produce energy.
- Students will have gained knowledge on Uganda’s potential for ethanol biodiesel production and able to apply advanced approaches/techniques to its production.
- Design systems for harnessing ethanol, biodiesel and biogas in the most appropriate way.

Course Outline

Biological Conversion (9 Hours)

- Biodegradation and biodegradability of substrate; Biochemistry and process parameters of bio-methanation;
- Biogas digester types; Digester design and biogas utilization; Chemical kinetics and mathematical modeling of biomethanation process;
- Economics of biogas plant with their environmental and social impacts; Bioconversion of substrates into alcohol:

- Methanol & ethanol Production, organic acids, solvents, amino acids, antibiotics etc.

Waste Treatment and Disposal **(6 Hours)**

- Size Reduction: Aerobic composting
- Environmental impacts;
- Land Fill method of solid waste disposal;
- Land fill classification; Types, methods & siting consideration;
- Layout & preliminary design of landfills:
- Composition, characteristics, generation;
- Movement and control of landfill leachate & gases;
- Environmental monitoring system for land fill gases

Energy Generation Form Waste **(6 Hours)**

- Types: Biochemical Conversion: Sources of energy generation, Industrial waste, agro residues;
- Anaerobic Digestion: Biogas production; Types of biogas plants; thermo-chemical conversion: Sources of energy generation,
- Environment benefits of biochemical conversion

Alcohol as Bio-energy source **(3 Hours)**

- Bio-Methane; Bio-Ethanol & Bio-Hydrogen

Bio-Diesel and Vegetable Oils as an energy Sources **(5 Hours)**

- History, Production methods of Bio-diesel:
- Transesterification, Fuel quality, standards and properties,
- Availability of Raw materials for bio-diesel, Applications.

General on Bio-energy **(3 Hours)**

- Bio-energy Systems; Future R&D of Bio-fuels & Bio-energy; Bio-fuels Testing
- Methods; Compare / contrast to diesel fuel test methods; Bio-fuels marketing; Petroleum Industry Perspective on Bio-fuels;
- Current Trends in Bio-fuels Use; Development: government and industrial

Power generation **(3 Hours)**

- Operation of spark ignition and compression ignition engine with methanol, ethanol & biogas;
- Biomass productivity: Energy plantation and power programme.

Laboratory: **(10 Hours)**

- Experimental Study on thermal performance and efficiency of biomass downdraft gasifier and sampling and analysis of air and flue gas from biomass energy system (gasifier, combustor and cook stoves using as chromatography technique)
- Biogas production by anaerobic digestion and analysis
- Fuels: density, viscosity, flash-point, fire point, pour-point, ASTM distillation of liquid fuels
- Proximate and ultimate analysis, calorific value of solid fuels

Delivery Methods

Lectures, exercises, laboratory work, assignment, study visits

Assessment

- Written exam, laboratory reports, written assignment, Examination 60% and

Assignment 40%

References

1. Donald L. Klass, (1998) “Biomass for Renewable Energy, Fuels, and Chemicals”, Academic Press, ISBN-13: 978-0-12-410950-6, ISNB-10: 0-12-410950-0
2. Anthony San Pietro, (1980) Biochemical and Photosynthetic aspects of Energy Production, Academic Press, New York, David Boyles, “Bio Energy Technology Thermodynamics and costs”, Ellis Hoknood, Chichester, 1984
3. R. C. Maheswari, “Bio Energy for Rural Energisation” , Concepts Publication, 1997
4. EL - Halwagi M M,(1986) “Biogas Technology : Transfer & Diffusion”, Elsevier Applied SC, London
5. Parker, Colin, & Roberts, “Energy from Waste - An Evaluation of Conversion Technologies”, Elsevier Applied Science, London, 1985
6. Manoj Datta, (1997)Waste Disposal in Engineered Landfills, Narosa Publishing House.
7. Bhide AD., Sundaresan BB, (1983)“Solid Waste Management in Developing Countries”, INSDOC, New Delhi.
8. Donald L.Klaswss,(2002) Biomass for Renewable Energy, Fuels, and Chemicals, Academic press

MEC7110: Solar Energy Technology

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
30	15	15	45	100	60	40	3

Course Description

This course introduces students to the fundamentals of solar energy including solar resource assessment, solar photovoltaics and solar thermal energy.

Course Objectives

The objectives of this course are:

- To introduce the basic concepts of solar geometry.
- To give students experience in the design of solar energy systems both photovoltaic and thermal systems.
- To introduce concepts of economic analysis on a proposed solar system.

Learning Outcomes

At the end of this course, a student should be able to:

- Use simulation tools to calculate the energy gain of a solar thermal system
- Analyze the function and characteristics of different types of solar thermal systems
- Size solar heating systems

- Show understanding of the various methods for protecting the system from overheating damage and to be able to choose the most suitable method for a specific application
- Design collector fields

Detailed Course Content

Introduction **(2 Hours)**

- Current and future potential of Solar Energy
- Solar radiation and insolation
- Solar geometry i.e. solar angles
- Radiation on tilted surfaces

Photovoltaics **(4 Hours)**

- Working principle of solar cells
- Types of solar cells, modules and arrays; production of wafers, cells and modules.
- PV Systems Components: Panels, controllers, inverters, batteries, other appliances and balance of system.

PV system engineering **(6 Hours)**

- Sizing, installation, commissioning, maintenance, troubleshooting, possible future technologies
- Applications: Grid connected systems, Solar Home Systems,
- Communication systems, Water pumping systems
- Consumer products, rural electrification systems.

Solar Thermal **(8 Hours)**

- Solar thermal conversion principles
- Collector and storage energy balance
- Solar thermal collectors, Flat plate collectors, Concentrators, Evacuated tubes collectors.
- Solar Thermal Applications: Water heating, Drying, Cooking, Cooling, electricity: Solar Tower, Trough systems
- Solar thermal power systems
- Evaporative processes

Solar thermal engineering **(6 Hours)**

- Sizing, installation, commissioning, maintenance, troubleshooting, possible future technologies.

Life cycle and financial analysis **(4 Hours)**

Mode of delivery

This course will be delivered through lectures, tutorials, exercises, field visits and group projects aimed at solving real life problems.

Method of Assessment

Students will be assessed through assignments, tests, practical work and projects which make up the course work and a final exam at the end of the course as follows:

Course work	40%
Final Exam	60%
Total Mark	100%

References

[1] John A. Duffie and William A. Beckman (1991). Solar Engineering of Thermal Processes (2nd Ed). Willey-Interscience, ISBN-13: 978-0471510567

[2] Stuart R. Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish (2006). Applied Photovoltaics, Centre for Photovoltaic Engineering, Australia

[3] Martin A. Green (1998). Solar Cells: Operating Principles, Technology and System Application, University of New South Wales, Kensington, Australia

[4] Jenny Nelson (2003). The Physics of Solar Cells, Imperial College Press - London, United Kingdom

[5] Tomas Markvart (1994). Solar Electricity (2nd Ed.), John Wiley & Sons, Ltd Chichester, New York, Weinheim, Brisbane, Toronto, Singapore

[6] France Lasnier and Tony Gan Ang (1990). Photovoltaic Engineering Handbook, Adam Hilger, Bristol, New York

[7] Martin A. Green (1995). Silicon Solar Cells: Advanced Principles & Practice Centre for Photovoltaic Devices and Systems University of New South Wales, Kensington, Australia

EMT7201: Advanced Engineering Mathematics

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	**PT**	**TH**	**CH**	**WTM**	**WEM**	**WCM**	**CU**
45	00	00	45	100	60	40	3

Course Description

The course gives the background for simple analytical derivation and numerical calculations for stochastic processes in discrete and continuous time as well as the application of Finite Element Methods to the solution of partial Differential Equations arising from Structural Engineering, Heat Conductions, Geomatic Engineering and Electrical Transmission Lines and using appropriate software tools e.g. MATLAB. Topics include Finite Element Discretization and the Direct Stiffness Method, Mathematical Formulation of Finite Elements, Computer Implementation of Finite Elements, Stochastic (Random) Processes and Estimation Theory.

Course Objective

The objectives are to develop a fundamental understanding of state-of-the-art finite element formulations and procedures, to develop an appreciation for the strengths and limitations of modern finite element methods and related software, to reinforce knowledge in solid mechanics with particular emphasis on nonlinear and dynamic problems, and to learn to utilize finite element methods as a research tool. Topics include finite element fundamentals and Weighted residual and finite element methods for the solution of hyperbolic, parabolic and elliptical partial differential equations, with application to problems in science and engineering. Error estimates. Standard and discontinuous Galerkin methods. The course gives the background for simple analytical derivation and numerical calculations for stochastic processes in discrete and continuous time as well as Estimation Theory.

Learning Outcomes

Students should be proficient in basics of Finite Elements Methods, Properties and Classification of Stochastic Processes, associated mathematically rigorous proofs, and some programming language. The Students should be able to articulate the Properties of classical Stochastic Processes and how these are applied in the classification of the same.

Detailed Course Content

Finite Element Methods (3 Hours)

Finite Element Discretization and the Direct Stiffness Method (6Hours)

The Direct Stiffness

- Finite Element Modeling: Mesh, Loads, BCs
- Multifreedom Constraints
- Superelements and Global-Local Analysis

Mathematical Formulation of Finite Elements (12 Hours)

Variational Formulation of Bar Element

- Variational Formulation of Plane Beam Element
- Advanced One-Dimensional Elements
- The Plane Stress Problem
- Three-Node Plane Stress Triangles
- The Isoparametric Representation
- Isoparametric Quadrilaterals
- Shape Function Magic
- FEM Convergence Requirements

Computer Implementation of Finite Elements (12 Hours)

- Implementation of One-Dimensional Elements
- FEM Program for Space Trusses
- FEM Programs for Trusses and Frames
- Implementation of iso-P Quadrilateral Elements
- Implementation of iso-P Triangular Elements
- The Assembly Process
- Solving FEM Equations
- A Complete Plane Stress FEM Program
- Stress Recovery
- Fitting Fields Over
- Thermomechanical Effects

Stochastic (Random) Processes (9 Hours)

- Characterization: Probabilistic Description,
- Expected Values Autocovariance Functions
- Classification: Stationary, Wide-Sense Stationary, Ergodic, Markov,
- Normal and Poisson Processes
- Analysis and Processing of Stochastic Processes: Spectral Density,
- Response of Linear Systems to Random Input,

Estimation Theory (5 Hours)

- Definitions: Estimators, Point-Estimators, Interval Estimators
- Properties of Point Estimators
- Types of Estimation: Estimation of a Distribution’s Unknown Parameter;
- Estimating the value of an inaccessible variable in terms of an accessible variable
- Maximum Likelihood Estimator
- Bayesian Estimator
- Mean Square Linear Estimator: Univariate Linear Regression;
- Orthogonality; Basic extension to Multivariate Linear Regression

Delivery method

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Assessment Method

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical/project Work 25%.

Reading List/References

[1] Hwei Hsu. Probability, Random Variables & Random Processes. Schaum's Outlines. ISBN 0-07-030644-3

[**2**] Carl W. Helstrom, 1984. Probability and Stochastic Processes for Engineers. Macmillan Publishing Company, USA. ISBN 0-02-353560-1

[**3**] Papoulis. Probability, Random Variables & Stochastic Processes, 3rd Edition., McGraw Hill.

[**4**] Michel K. Ochi, 1990. Applied Probability and Stochastic Processes in Engineering and Physical Sciences. John Wiley & Sons, Inc. USA. ISBN 0-471-85742-4

[**5**] George R. Cooper, and Clare D. McGillem, 1999. Probobilistic Methods of Signal and Systems Analysis. 3rd Edition. Oxford University Press, Newyork, USA. ISBN 0-19-512354-9

[6] Yannis Viniotis. Probability & Random Processes for Electrical Engineers,McGraw Hill.

[7] Jorge I Aunon, V. Chandrasekar: Introduction to Probability & Random Processes, McGraw Hill

[8] Venkatarama Krishnan, 2006. Probability and Random Processes (Wiley Survival Guides in Engineering and Science), Wiley-Interscience; 1 Edition. ISBN-10: 0471703540, ISBN-13: 978-0471703549

[9] Donald G. Childers, 1997. Probability and Random Processes: Using Matlab with Applications to Continuous and Discrete Time Systems. Richard D Irwin. ISBN-10: 0256133611, ISBN-13: 978-0256133615

[10] Leon Garcia, 1993. Probability and Random Processes for Electrical Engineering. Addison Wesley Publishing Company; 2 Sol Edition. ISBN-10: 020155738X, ISBN-13: 978-0201557381

[11] Roy D. Yates, David J. Goodman, 2004. Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers. Wiley; 2nd Edition. ISBN-10: 0471272140, ISBN-13: 978-0471272144

[12] Paul M. Kurowski , 2004. Finite Element Analysis For Design Engineers. SAE International, ISBN-10: 9780768011401, ISBN-13: 978-0768011401, ASIN: 076801140X

[13] Young W. Kwon), Hyochoong Bang, 2000. The Finite Element Method Using MATLAB, Second Edition. CRC Press. ISBN-10: 0849300967, ISBN-13: 978-0849300967

[14] M. Asghar Bhatti, 2004. Fundamental Finite Element Analysis and Applications: with Mathematica and Matlab Computations. Wiley; 1st Edition. ISBN-10: 9780471648086, ISBN-13: 978-0471648086, ASIN: 0471648086

RET7203: Project Management

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course Description
An overview of the theory and practice of managing projects in any organization, applying widely used software tools for project management and risk analysis. Emphasis is on leadership in project management: managing projects or tasks in a team environment; building teams; and utilizing communication, organization and conflict management skills. Simulation tools and statistical techniques are used to analyze uncertainty in project selection, budget allocation and time estimation. Project management knowledge areas are examined and linked to industry practices for successful management of projects.

Course Objective
The aims of this course are to:

- Enable students appreciate the role of projects in any industrial setting.
- Give students and understanding of the conduct of projects in all its various aspects such as project planning and management, tendering and procurement.

Learning Out Comes
At the end of this course, a student should be able to:
Distinguish between a programme, project and a routine activity
Demonstrate knowledge and skills of processes, techniques, standards, empirical guidelines, computer software, team building used in project
Develop project requirements especially human and financial
Explain the various project monitoring and control techniques

Detailed Course Content

Foundations of Project Management (3 Hours)

An overview of the theory and practice of managing projects in any organization. Emphasis is on leadership in project management: managing projects or tasks in a team environment; building teams; and utilizing communication, organization and conflict management skills. Discussion covers the various phases of a project, including initiating, planning, executing, monitoring and controlling, and closing the project. Project management knowledge areas are examined and linked to industry practices for successful management of projects. The goal is to gain a solid understanding of how to successfully manage each phase of the project life cycle, work within organizational constraints, set goals linked directly to stakeholder needs and utilize proven project management tools to complete projects on time and within budget while meeting specifications. Essential concepts, processes and techniques are applied through management of a team project, which requires regular progress reports and reviews.

Project Risk Management **(6 Hours)**

An in-depth analysis of risk management methodologies, from both strategic and tactical perspectives. State-of-the art tools and techniques for identifying, measuring and monitoring risks in the project management environment are examined. Both qualitative and quantitative risk analyses are conducted, and strategies for proactive risk aversion and reactive risk response are developed. Focus is on how a comprehensive risk management approach can enable a project team to proactively manage issues that adversely impact the successful control and completion of a project.

Project Communications Management **(3 Hours)**

An overview of conflict resolution processes and methods and the skills needed to manage the human elements within project management—a task as challenging as managing the technical aspects. Topics include critical communication and conflict resolution issues faced by project workers in today's global corporate environment. Innovative approaches to successfully negotiating and resolving conflicts among team members, colleagues, managers and stakeholders are introduced and practiced. Proven techniques to make conflict a constructive—rather than a destructive—experience are analyzed. Emphasis is on case study analysis, effective communication behaviors, negotiation skills and virtual team processes to successfully lead both domestic and global projects.

Project Quality Management **(9 Hours)**

A study of the policy, processes and procedures involved in assuring that projects will satisfy the objectives for which they were undertaken. Emphasis is on quality planning, quality assurance, quality control, and process improvement. Discussion covers all the activities that determine quality objectives, policies, and responsibilities. The importance of customer satisfaction, prevention over inspection, management responsibility and continuous improvement is recognized. Topics include control charts, cause and effect diagrams, Pareto charts, failure mode and effect analysis, design reviews and cost of quality. Course content and approach are compatible with the International Organization for Standardization.

Project Procurement Management **(6 Hours)**

An examination of the tools needed for project procurement management. Focus is on determining what needs to be purchased or acquired and determining when and how to acquire it. Topics include planning the contracting efforts (documenting products and services and identifying potential sellers); requesting sellers' responses (obtaining information, quotation, bids, offers or proposals); selecting the seller (receiving and reviewing offers, selecting among those potential offers and negotiating a contract); administering contracts (managing the relationship between buyers and sellers, including documentation, corrective actions and contract changes); and closing contracts (completing the contract and settling all open issues).

Financial and Strategic Management of Projects **(9 Hours)**

Financial and strategy making in project management. Covers: project cost estimation developed from work breakdown structure; formulating, monitoring and controlling project budgets; impact of project scope and schedule; managing project changes; management reserves to cover risks and contingencies; top-down and bottom-up budgeting; Earned Value Management as a key tool to monitor, evaluate and forecast project costs, schedule, results and performance; deriving project cash flows; investment project evaluation; discounted cash flow, internal rate of return and net present value methodologies; cost of capital; and capital budgeting. Broader issues examined include links between project and corporate financial performance, business ethics, corporate social responsibility, project and organizational culture issues, communications and information flow, financial risk analysis and project sustainability, for government as well as privately funded projects.

Advanced Project Methods (9 Hours)

An overview of advanced methods of managing projects, applying widely used software tools for project management and risk analysis. Topics include analytical approaches and quantitative methods in project management, such as earned value management and techniques for estimating project duration and cost, optimizing allocation of resources, expediting projects and scheduling algorithms. Simulation tools and statistical techniques are used to analyze uncertainty in project selection, budget allocation and time estimation. Discussion covers project portfolio management and how multiple projects and programs fit into strategic direction of an organization. The processes, tools and techniques of project management are applied to a team project with emphasis on quantitative and analytical methods.

Delivery Method

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques

Assessment Methods

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Project Work 25%.

Reading List/References

1. Meredith, J.R. and Mantel, S.J. (2009), Project management: a managerial approach. 7th edition./ Wiley.
2. Jack Gido and James P.(2004) Clements Successful Project Management An International Thompson Publishing Company ISBM 0-538-88152-6
3. Frederick L. Harrison, Dennis Lock,(2003) Advanced Project Management: A Structured Approach, Gower Publishing, Ltd., ISBN 0566078228.
4. Scott Berkun, (2005The Art of Project Management, O'Reilly, ISBN 0596007868..
5. Harrold Kerzner. Project management. A systems Approach to Planning, Building, Scheduling and Planning. 10th Edition. John Wiley & Sons.
6. Project Management Institute. (2004). A Guide to the Project Management Body of Knowledge.
7. David I. Cleland, Ronald Gareis. (2006) Global Project Management Handbook. Planiing, Organizing and Controlling International Projects. 2006. McGraw Hill.

MEC7229: Conventional Power Generation

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
35	10	10	45	100	60	40	3

Course Description:
This course covers the fundamentals of Power Plants. It covers the design and analysis of Steam Power Plants, Gas Turbine Power Plants, Combined Cycle Power Plants, Diesel Power Plants and Nuclear Power Plants and the related Economics of Power Generation.

Course Objective:
The goal of the course is to provide a fundamental understanding of the principles of conventional power plants, including coal, gas, steam Nuclear and Combined Power Plants.

Student Learning Outcomes:
At the end of the course the students will:

- Understand the different types of thermal power systems and their components
- Develop the ability to analyse and evaluate the performance of different thermal energy conversion systems
- Identify and rate the different fossil fuels used as sources of energy in thermal energy conversion and their environmental impacts
- Develop a mathematical and theoretical skill and knowledge to analysis and design of steam generators (boiler)
- Have sound understanding on analysis, modelling and design of steam thermal energy systems.

Course Outline:
Fundamentals of Power Plant **(5 Hours)**

- Introduction; Concept of Power Plants; Classification of Power Plants;
- Review of Thermodynamics Cycles Related to Power Plants;
- Classification of Power Plant Cycle.

Steam Power Plant **(5 Hours)**

- Introduction; Essentials of Steam Power Plant Equipment;
- Steam generators; steam turbines; fuels and combustion
- Boilers and heat exchangers

Gas Turbine Power Plant **(6 Hours)**

- Introduction;
- Classification of Gas Turbine Power Plant;
- Elements of Gas Turbine Power Plants;
- Regeneration and Reheating

Combined Cycle Power Plants **(4 Hours)**

- Combined cycle power plants; combined heat and power;
- Thermodynamic analysis of CHP cycles.

Diesel Power Plant **(6 Hours)**

- Introduction; Operating Principle; Basic Types of IC Engines;
- Application of Diesel Power Plant;
- General Layout of Diesel Power Plant;
- Performance of Diesel Engine; Fuel System of Diesel Power Plant;
- Diesel Plant Operation; Efficiency of Diesel Power Plant;
- Heat Balance Sheet

Nuclear Power Plant **(5 Hours)**

- Introduction; Nuclear Energy Concepts and Terms;
- Chemical and Nuclear Equations; Nuclear Fusion and Fission;
- Nuclear Reactor; Classification of Reactors;
- Cost of Nuclear Power Plant; Safety Measures for Nuclear Power Plants;
- Major Nuclear Power Disasters

Economics of Power Generation **(4 Hours)**

- Daily load curves-load factor-diversity.
- factor-load deviation curve-load
- management-number and size of generating
- Unit cost of electrical energy-tariff-power factor improvement.

Mode of Delivery

Include formal lectures (including those from Visiting Lecturers), case studies, tutorial exercises, practical demonstrations, directed learning and individual work

Method of Assessment

The method of assessment is by written examination and both analytical and experimental work. Examination will carry 60% and assignments 40%.

Reference text books:

1. Paul Breeze, (2005) Power Generation Technologies.
2. Frank Kreith, (1999) Mechanical Engineering Handbook, Energy Conversion.
3. C. Elanchezhian (2007) "Power Plant Engineering" I K International Publishing House ISBN-13: 978-8189866303
4. Larry Drbal et al (1995)"Power plant Engineering" Springer; 1 edition (December 31, 1995) ISBN-13: 978-0412064012
5. Philip KiamehHard (2002) Power Generation Handbook : Selection, Applications, Operation, Maintenance McGraw-Hill Professional ISBN-10: 0071396047, ISBN-13: 978-0071396042

MEC7231: Energy Management

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
45	0	0	45	100	60	40	3

Course Description:

The course Analysis and optimization of energy systems deals mainly with energy conversion; energy management; energy audit; material and energy balance; Energy Monitoring and Targeting; Global Environmental Concerns; thermal energy management; Energy Efficiency on Boilers; Energy Efficiency on Steam System; Energy Efficiency on Insulation and Refractory; FBC Boilers; Waste Heat Recovery; Electric Motors; Compressed Air System; HVAC and Refrigeration System; Fans and Blowers; Pumps and Pumping System; DG Set System.

Course Objectives:

To have the student develop a fundamental understanding of the basic physical principles underlying energy management and audit, energy efficiency in thermal and electrical utilities, energy storage systems and power cogeneration

Learning outcomes:

Upon completion of this course the student will be able to:

- Practice energy efficiency and effective utilization of energy in the application areas
- Develop energy system models
- Use simple simulation tools for energy system specification

Course Outline:

Energy Conservation **(2 Hours)**

- Energy Conservation and its Importance;
- Energy Strategy for the Future; the Energy policy , and its Features

Energy Management **(2 Hours)**

- Definition and Objectives of Energy Management;
- Importance; National need of Energy Management;
- Duties and responsibilities of energy managers

Energy Audit **(4 Hours)**

- Energy Audit types and methodology; Energy Audit Reporting Format;
- Understanding Energy Costs; Benchmarking and Energy Performance; Matching

- Energy Usage to Requirement; Maximizing System Efficiency; Fuel and Energy Substitution; Energy Audit Instruments; Duties and responsibilities of energy auditors.

Material and Energy Balance (6 Hours)

- Basic Principles; The Sankey Diagram and its Use;
- Material Balances; Energy Balances;
- Method for Preparing Process Flow Chart; Facility as an Energy System;
- How to Carryout Material and Energy and Balance. Energy Action Planning Key elements; Force field analysis;
- Energy policy purpose, perspective, contents, formulation, ratification;
- Organizing the management: location of energy management, top management support, managerial function, accountability;
- Motivation of employees: Information system designing barriers, strategies; Marketing and communicating: Training and planning.

Energy Monitoring and Targeting (4 Hours)

- Definition; Elements of Monitoring and Targeting System;
- A Rationale for Monitoring, Targeting and Reporting; Data and Information Analysis;
- Relating Energy Consumption and Production, Case Study.

Global Environmental Concerns (4 Hours)

Global Environmental Issues; Ozone Layer Depletion; Global Warming; Loss of Bio-Diversity; Climate Change Problem and Response; The Conference of the Parties (COP); Prototype Carbon Fund (PCF); Sustainable Development. Electrical Energy Management

Supply side: Methods to minimize supply-demand gap, renovation and modernization of power plants, reactive power management, HVDC, and FACTS. Demand side: conservation in motors, pumps and fan systems; energy efficient motors.

Thermal Energy Management (3 Hours)

Energy conservation in boilers, steam turbines and industrial heating systems; Application of FBC; Cogeneration and waste heat recovery; Thermal insulation; Heat exchangers and heat pumps; Building Energy Management.

Energy Efficiency on Boilers (3 Hours)

Introduction; Boiler Systems; Boiler Types and Classifications; Performance Evaluation of Boilers; Boiler Blow-down; Boiler Water Treatment; Energy Conservation Opportunities; Case Study.

Energy Efficiency on Steam System (3 Hours)

Introduction; Properties of Steam; Steam Distribution; Steam Pipe Sizing and Design; Proper Selection, Operation and Maintenance of Steam Traps; Performance Assessment Methods for Steam Traps; Energy Saving Opportunities

Furnaces Types and Classification of Different Furnaces; Performance Evaluation of a Typical Furnace General Fuel Economy Measures in Furnaces; Case Study

Electric Motors (Case Study) **(3 Hours)**

Introduction; Motor Types; Motor Characteristics; Motor Efficiency; Motor Selection; Energy Efficient Motors; Factors Affecting Energy Efficiency and Minimizing Motor Losses in Operation; Rewinding Effects on Energy Efficiency; Speed Control of AC Induction Motors; Motor Load Survey: Methodology.

Compressed Air System (Case Study) **(3 Hours)**

- Introduction; Compressor Types; Compressor Performance;
- Compressed Air System Components;
- Efficient Operation of Compressed Air Systems; Compressor Capacity Assessment; Checklist for Energy Efficiency in Compressed Air System.

HVAC and Refrigeration System (Case Study) **(3 Hours)**

- Introduction; Types of Refrigeration System;
- Common Refrigerants and Properties;
- Compressor Types and Application
- Selection of a Suitable Refrigeration System;
- Performance Assessment of Refrigeration Plants;
- Factors Affecting Performance and Energy Efficiency of Refrigeration Plants;
- Energy Savings Opportunities

Mode of Delivery

Include formal lectures (including those from Visiting Lecturers), case studies, tutorial exercises, practical demonstrations, directed learning and individual work

Method of Assessment

The method of assessment is by written examination and both analytical and experimental work. Examination will carry 60% and assignments 40%.

References

[1] Frank Kreith, D.Yogi Goswami, (2007*) Energy Management and conservation Handbook*,

[2] Albert Thumann, P.E., C.E.M., William J. Younger, C.E.M.,(2008) *Handbook Of Energy Audits*, Sixth Edition

[3] Wayne C. Turner (2001) *Energy management handbook* 4th Edition. Fairmont Press, ISBN0824746163, 9780824746162

MEC7233: Modelling and Optimization of Energy Technology

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
40	0	10	45	100	60	40	3

Course Description:

This course is focused on the basics of modelling with emphasis of process and process modelling; steady and unsteady state process modelling and simulation; role of modelling in technology transfer; mathematical modelling; statistical models; dimensional analysis and modelling

Course Objective:

Computer modelling and simulation has become a very important technology for assisting engineers with their non-trivial task of designing/analysing energy technology and environmental systems such that the result is low energy consumption, good indoor conditions and minimal impact on the environment in general. This course intended to provide the skill and competence with regard to modelling and simulation in Energy technology

Course Learning Outcome:

The goal of the course is that the students should learn methods for the modelling and simulation of physical plants with regard to energy technology.

Course Outline:

Why Modelling, Process and Process Modelling, **(6 Hours)**

- General Aspects of Modelling Methodology,
- The Life-cycle of a Process and Modelling,
- Modelling and Research and Development Stage,
- modelling and Pilot Stage, modelling and Detailed Engineering Stage,
- modelling and Operating Stage,
- Considerations About the Process Simulation, The Simulation of a Physical Process

Classification of Models **(6 Hours)**

- Steady-state Flow sheet modelling and Simulation,
- Unsteady-state Process modelling and Simulation,
- Molecular modelling and Computational Fluid Dynamics,
- Optimization Methods, Reliability of Models and Simulations,
- modelling and Simulation in Innovations, Role of modelling in Technology Transfer and Knowledge

Mathematical modelling Based on Transport Phenomena, **(13 Hours)**

- Development of a Mathematical Model of a process, Flow Models,
- Fundamental and Combined Flow Models,
- Examples of flow models,

- Flow modelling using Computational Fluid Dynamics,
- Complex Models and Their Simulators,
- Some Aspects of Parameters Identification in Mathematical modelling

Stochastic Mathematical modelling, **(6 Hours)**

- Introduction to Stochastic modelling, Mechanical Stirring of a Liquid,
- Numerical Application, Solid Motion in a Liquid Fluidized Bed,
- Statistical Models, Basic Statistical modelling, Characteristics of the Statistical Selection, Correlation Analysis, Regression Analysis, Experimental Design Methods.

Dimensional Analysis and modelling, **(9 Hours)**

- Dimensional Analysis in Energy Engineering,
- Energy flow Problems Particularized by Dimensional Analysis,
- Common Dimensionless Groups and Their Relationships,
- Physical Significance of Dimensionless Groups,
- Particularization of the Relationship of Dimensionless Groups Using Experimental Data, Physical Models and Similitude.

Mode of Assessment

The method of assessment is by written examination and evaluation from case studies.

Mode of Delivery

Include formal lectures (including those from Visiting Lecturers), case studies, tutorial exercises, practical demonstrations, directed learning and individual work

References

- Tanase G. Dobre, Jos G. Sanchez Marcan (2007) *Modelling, Simulation and Similitude*, Chemical Engineering, Wiley ISBN-13: 978-3527306077
- Josef Kallrath et al (2009) *Optimization in the Energy Industry (Energy Systems)* Springer; 1 edition ISBN 13 978-3540889649
- Adrian Bejan, Eden Mamut (1999) *Thermodynamic Optimization of Complex Energy Systems* Springer ISBN-13: 978-0792357254
- Stanislaw Sieniutycz ,Jacek Jezowski (2009) *Energy Optimization in Process Systems* Elsevier Science ISBN-13: 978-0080451411

MEC8102: Impact of Energy Generation on Environment

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
45	0	0	45	100	60	40	3

Course Description:

This course provides students with exposure to a wide range of current energy and energy-related environmental policies that foster the deployment of sustainable energy technologies fuels, and practices. The primary focus will be on environmental disasters due to energy consumption, and the conventions and protocols related to energy and environment.

Course Objective:

- To introduce the student to the global energy situation and the interactions between the human activities in the energy field and the environment.

- To describe the available management systems and tools as well as technical mitigation methods relevant to the energy field and applicable within the existing legal framework.

Course Learning Outcomes:

Upon successfully completing this course the student should be able to:

- Describe from an overall perspective the major energy conversion processes,
- Draw distinctions between applications in industrialized nations and developing countries.
- Present a first-order environmental impact statement and life cycle analysis for an energy-intensive industrial system.
- Perform a basic scenario analysis with an energy forecasting tool
- Conduct major environmental studies embodying the concepts and tools and including the assimilation of relevant technical, financial, and social aspects.

Course Outline:

Earth Energy Systems (6 Hours)

- Origin of the earth; Earth's temperature and atmosphere; Sun as the source of energy;
- Biological processes; photosynthesis; food chains; Energy sources:
- Classification of energy sources, quality and concentration of energy sources; Overview of world energy scenario;
- Fossil fuel reserves-estimates, duration, overview of Uganda's energy scenario, energy and development linkage.

Ecological Principles (4 Hours)

- Ecological principles of nature; Concept of ecosystems;
- Different types of ecosystems; ecosystem theories;
- Energy flow in the ecosystems; biodiversity

Energy Systems and Environment (7 Hours)

- Environmental effects of energy extraction, conversion and use;
- Sources of pollution; primary and secondary pollutants;
- Consequence of pollution growth; Air, water, soil, thermal, noise pollution
- Cause and effect; Causes of global, regional and local climate change;
- Pollution control methods; Environmental laws on pollution control.

Air Pollution **(3 Hours)**

- Sources and Effect - Acid Rain - Air Sampling and Measurement –
- Analysis of Air Pollutants
- Air Pollution Control Methods and Equipment
- Issues in Air Pollution control.

Solid Waste Management **(6Hours)**

- Sources and Classification; Characteristics of solid waste-Potential methods of solid
- waste Disposal; Process and Equipments for Energy Recovery from Municipal Solid Waste and Industrial Solid Waste.

Water Pollution **(4 Hours)**

- Sources and Classification of Water Pollutants
- Characteristics - Waste Water Sampling Analysis
- Waste Water Treatment and Monitoring compliance with Standards
- Treatment, Utilization and Disposal of Sludge.

Other Types of Pollution **(4 Hours)**

- Noise Pollution and its impact - Oil Pollution
- Pesticides - Radioactivity Pollution Prevention and Control

Pollution from Thermal Power Plants and Control Methods **(3 Hours)**

- Instrumentation for pollution control - Water Pollution from Tanneries and other Industries and their control

Sustainability **(3 Hours)**

- Global warming; Green House Gas emissions, impacts, mitigation; Sustainability;
- Externalities; Future Energy Systems; Clean energy technologies; United Nations Framework
- Convention on Climate Change (UNFCCC); Sustainable development; Kyoto Protocol; Conference of Parties (COP);; Prototype Carbon Fund (PCF).

Delivery Method

Include formal lectures (including those from Visiting Lecturers), case studies, tutorial exercises, practical demonstrations, directed learning and individual work

Practicals

Application of LEAP as a tool for energy and environment projection for theory and practical/tutorials **(10 Hours)**

Assessment

The method of assessment is by written examination and evaluation from case studies.

References

[1] Frank Kreith (1999), *Mechanical Engineering Handbook*, Environmental Engineering

[2] R E Hester, R M Harrison (1999) *Environmental Impact of Power Generation (Issues in Environmental Science and Technology)* Royal Society of Chemistry ISBN-13: 978-0854042500
[3] R. Giero and P. Stille (2004) *Energy, Waste and the Environment*: A Geochemical Perspective (Geological Society Special Publication) Geological Society of London ISBN-13: 978-1862391673
[4] Adrian Bejan , Peter Vadász , Detlev G. Kröger (1999) *Energy and the Environment (Environmental Science and Technology Library)* ISBN-13: 978-0792355960

MEC8103: Advanced Heating, Ventilation, Air Conditioning and Refrigeration

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
40		10	45	100	60	40	3

Course Description
This course covers the concepts of HVAC which include: Human Comfort, Thermal Loads, How an HVAC System Functions, Energy Conservation Opportunities (ECO's), Psychometrics, Industrial Refrigeration Systems, Air Conditioning and Refrigeration System components.

Course Objectives:
- To introduce the basic principles of Refrigeration cycles and air-conditioning.
- To equip the student with the knowledge for HVAC maintenance-operation and maintenance care
- To discuss the new refrigerants technology related to the ozone depletion and global warming phenomena.
- To introduce the student to principles of refrigeration cycle servicing, electrical circuit protection of HVAC, service diagnosis and repairs and trouble shooting and fault finding.

Course Outcomes:
At the end of the course the student should
- Understand and apply the basics of human comfort
- Be able to determine cooling and heating loads for an occupied space
- Be able to design, size and select a HVAC system

Course content
1. **Fundamentals of HVAC** **(9 Hours)**
   - Human comfort
   - Fresh air requirements
   - Thermal Loads
   - Psychrometrics
   - How an HVAC System Functions

- Energy Conservation Opportunities (ECOs)

2. **Refrigeration systems** **(9 Hours)**
    - Vapour compression Refrigeration system analysis
    - Absorption refrigeration system
    - Air refrigeration systems
    - Refrigeration equipment
    - Simulation of refrigeration systems

3. **Cooling and heating load determination** **(6 Hours)**
    - People loads
    - Equipment loads
    - Product loads
    - Solar loads
    - Ventilation loads
    - Other loads
    - Energy evaluation and management in the built environment

4. **HVAC system Components** **(3 Hours)**
    - Distribution: Fans, ducts
    - Conversion
    - Controls

5. **HVAC system design and selection** **(6 Hours)**
    - Duct and pipe sizing
    - Selection of systems
    - Classification of HVAC systems

6. **Introduction and use of computer-based load estimation packages software (6Hours) (6 Hours)**
    - Use of CFD packages as tools to simulate flows in building
    - Optimization of air conditioning design, energy estimation methods and software

Mode of delivery

This course will be delivered through lectures, tutorials, exercises, field visits and group projects aimed at solving real life problems.

Method of Assessment

Students will be assessed through assignments, tests, practical work and projects which make up the course work and a final exam at the end of the course as follows:

Course work	40%
Final Exam	60%
Total Mark	100%

Reference textbooks

[1] Burr, R. W., et al., 1998. Fundamentals of Air System Design, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Atlanta, GA.

[2] Fenton, D. L., 2000. Fundamentals of Refrigeration, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA. [
[3] Hegberg, R. A., 1999. Fundamentals of Water System Design, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Atlanta, GA.
[4] Johnson, R. R., 1999. Fundamentals of HVAC Systems, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Atlanta, GA.
[5] ASHRAE, 2005. ASHRAE Handbook Fundamentals 2005, Chps. 1, 2, 6, 8, 19, 27, 28, 30-35, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Atlanta, GA.
[6] Jones, W. P., 2001. Air Conditioning Engineering, 5th Ed., Butterworth-Heinemann, Oxford & Boston.
[7] Sauer, H. J., Howell, R. H. and Coad, W. J., 2001. Principles of Heating, Ventilating, and Air Conditioning, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA.

MEC7230: Numerical Methods in Energy Engineering

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
40	0	10	45	100	60	40	3

Course Description

This course give an overview of the fundamentals of numerical methods used in engineering related to energy systems such as CFD (computational fluid dynamics), Heat transfer, and structural analysis. It gives a background on how to apply numerical methods in the design and testing of related equipment and other hardware. The main emphasis is on practical use of codes based on Finite Element/Volume methods for subsonic incompressible and compressible recirculating flows

Course Objectives

- To develop an understanding for: the major approaches and methodologies used in CFD, the interplay of physics and numerics, the methods and results of numerical analysis
- To help the student gain experience in the actual implementation of numerical methods in energy engineering
- To develop the student skills in: implementing and using basic CFD methods, computer use and programming and debugging

Learning Outcomes

At the end of the course students should be able to:

- Describe the physical significance of each term in the governing equations for CFD.
- Effectively use a commercial CFD package to solve practical CFD problems.
- Quantify and analyze the numerical error in solution of the CFD, PDE's.
- Formulate explicit and implicit algorithms for solving the Navier Stokes Equations
- Create and demonstrate verification strategies for evaluating CFD code.

Course content

1. Introduction to CFD **(3 Hours)**

- What is computational fluid dynamics?
- Principles of fluid mechanics
- Different ways of expressing the fluid-flow equations
- Basic principles of CFD
- The main discretisation methods

2. Fluid-flow equations **(6 Hours)**

- Control-volume approach
- Conservative flow equations – control-volume and differential forms
- Other differential forms of the fluid-flow equations
- Compressible and incompressible flow
- Non-dimensionalisation

3. Approximation and Simplified Equations **(5 Hours)**

- Steady-state *verses s* time-dependent
- Two-dimensional *verses* three-dimensional
- Incompressible *verses* compressible
- Inviscid *verses* viscous
- Hydrostatic *verses* non-hydrostatic
- Boussinesq approximation (buoyancy-affected flow)
- Depth-averaged / shallow-water equations
- Reynolds-averaged equations (turbulent flow)
- Potential flow

4. The Scalar Transport Equations **(6 Hours)**

- The generic scalar-transport equation
- Control-volume notation
- Discretising diffusion
- Discretising the source term
- Assembling the algebraic equations
- Discretisation properties
- Implementation of boundary conditions
- Solution of the algebraic equations

5. The Momentum Equations **(4 Hours)**

- Scalar-transport equations for momentum
- Pressure-velocity coupling
- Pressure-correction methods

6. Time Depended Methods **(5 Hours)**

- The time-dependent scalar transport equation
- One-step methods
- Multi-step methods
- Uses of time-marching in CFD

8. Turbulence Modelling **(6 Hours)**

- Review of turbulence
- Objectives in turbulence modelling
- Eddy-viscosity models
- Advanced turbulence models
- Wall boundary conditions

9. The CFD Process **(5 Hours)**

- Introduction
- The computational mesh
- Boundary conditions
- Flow visualisation

Mode of delivery

This course will be delivered through lectures, tutorials, exercises, field visits and group projects aimed at solving real life problems.

Method of Assessment

Students will be assessed through assignments, tests, practical work and projects which make up the course work and a final exam at the end of the course as follows:

Course work	40%
Final Exam	60%
Total Mark	100%

Reference textbooks

[1] H K Versteeg & W Malalasekera, 1995. An Introduction to Computational Fluid Dynamic (The Finite Volume Method), Longman Scientific & Technical, ISBN 0-582-21884

[2] Richard Hamming, 1987. Numerical Methods for Scientists and Engineers, Dover Publications 2nd Ed. ISBN-10: 9780486652412.

[3] John Anderson, 1995. Computational Fluid Dynamics, McGraw-Hill Science/Engineering/Math; 1st Ed, **ISBN-10:** 9780070016859.

[4] Richard Pletcher, John Tannehil, Dale Anderson (1997). Computational Fluid Mechanics and Heat Transfer, 2nd Ed. (Series in Computational and Physical Processes in Mechanics and Thermal Sciences) Taylor & Francis Publishers, ISBN-10: 9781560320463

MEC7232: Other Alternative Energy Resources

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
40	0	10	45	100	60	40	3

Brief Description

The course cover other forms of Renewable or alternative energy sources which are not the main focus of the other courses in this program. These are geothermal energy, Hydrogen, fuel cell, Oceanic and wave energy.

This course covers geothermal, wind, wave, tidal energy hydrogen and fuel cells. It addresses the potential for these resources towards contributing to energy mix within Uganda at the region at present and in future. The technologies for tapping the power and heat from the above resources and their respective applications will be clearly demonstrated. .

Course Objectives

- To equip students with advanced knowledge in all the other types of renewable energy other than solar energy and hydropower.
- To present the state-of-the-art technologies for tapping power and heat from these resources.
- To address the feasibility of harnessing power from any of the above resource types for Uganda and regional applications at present and future.

Learning Outcomes

- Students should be able to describe the mechanisms or processes used in obtaining the usable energy from wind, geothermal, tidal wave energy, fuel cells and ocean energy.
- Students should be able to estimate the power from wind and geothermal and other sources using basic techniques and tools.
- Students should have the skills on how to make integrated designs for harnessing energy from the above resources.

Course Content

Geothermal **(10 Hours)**

- Geothermal: Geophysics , Geochemical
- Regional Geothermal Potential;
- Dry Rock and Aquifer Analysis;
- Technology for Geothermal Resources;
- Applications: low and high temperature applications, power cycles
- Electricity generation

Wind Energy **(12 Hours)**

- Regional wind resources;
- energy from the wind; characteristics of wind;
- wind measurement and analysis (The Betz model and Raleigh wind distribution)
- Design of wind energy conversion systems
- Electricity generation; Water pumping,
- Environmental impact.

Wave Energy **(3 Hours)**

- Principle of wave energy
- Properties of deep water
- Wave characteristics
- Wave energy
- Economics and environment

Tide Power **(3 Hours)**

- The cause of tides
- Enhancement of tides
- Tidal flow power; tidal power range
- Tidal energy conversion systems
- Economic
- Environmental factors

Fuel Cell **(6 Hours)**

- Thermodynamics and electrochemical principles;
- Basic design, types, applications; Hydrogen;
- Electrochemistry of Fuel Cells; Fuel Cell Systems and Technologies;
- Hydrogen Production Technology; Hydrogen Storage;
- Fuel Cells in Transportation; Stationary and Mobile Fuel Cell Systems; Policies and Future Research and Development of Fuel Cell Technology;
- Power from waste

Ocean Energy **(3 Hours)**

- Ocean energy resources, ocean energy routes,
- Principles of ocean thermal energy conversion systems,
- ocean thermal power plants,
- Principles of ocean wave energy conversion

Wave Energy **(3 Hours)**

- Wane motion;
- wave energy and power; wave patterns;
- devises
- Economic and environmental factors.

Delivery Method

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems.

Assessment Method

Assessment will be done through coursework which will include assignments, class room and test and written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

References

1. W.J. Minkowycz and E.M. Sparrow,(2001) Advances in numerical heat transfer, Taylor & Francis Books, 2001.
2. Leon Douglas Smoot & Philip J. Smith (1985), Coal Combustion and Gasification, Springer, 1985

3. Prabir Basu, (2000) Combustion and gasification in Fluidized Bed, CRC Press, London
4. Godfrey Boyle,(2004): Renewable Energy "Power for a Sustainable Future" Second Edition, Oxford University Press. ISBN-0-19-926178-4

MEC7112: Manufacturing Processes and Product Quality Control

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course description

This course is designed to present the concept of total quality control through the study of techniques presently used by industry.

Course objectives:

Students will learn to view quality from a variety of functional perspectives and in the process, gain a better understanding of the problems associated with improving quality. To equip students with the knowledge of quality tools utilized in service and international/environments and the ability to select the best tools in a particular context.

Learning objectives:

Upon completion of this course the student should be able to do the following;

- Compare and contrast the key elements of total quality.
- Explain the rationale for the total quality approach to doing business.
- Examine and describe the relationship between quality and competitiveness.
- Compare and contrast the tools used in the total quality setting.
- Define decision making and examine problem solving as it relates to total quality.
- Explain the requirements for total quality implementation

Course content:

- Introduction, evolution and integration of total quality management in Organizations (4 hours)
- Quality management philosophies and frameworks (4 hours)
- Process management and performance measurement (4 hours)
- Quality in product and process design (6 hours)
- Defining quality characteristics and diagnosing quality problems (6 hours)
- Statistical Process Control (6 hours)
- Lean and agile management (6 hours)
- The sixth sigma approach (4 hours)
- Building and sustaining Total Quality Management in organizations (5 hours)

Delivery Method:
The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques

Method of assessment
Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Reading list/references

1. Evans. J.R. and Lindsay, W.M (2008), Management for Quality and Performance Excellence, 7th Edition HARD BOUND, Thomson South-Western Publishing
2. Jiju Antony and David Preece; Editors, (2002), Understanding, Managing and Implementing Quality Frameworks, techniques and cases, Routledge, London.
3. James Fairfield Sonn , (2001), Corporate Culture and the Quality Organisation, Quorum Books., Westport, CT. ISBN 0-89930-903-8
4. Greg Bounds, Lyle Yorks, Mel Adams, Gipsie Ranney, (1994), Beyond Total Quality Management: Toward The Emerging Paradigm, Irwin/McGraw-Hill, ISBN-10: 0070066787, ISBN-13: 978-0070066786

MEC7113 : Business and Operations Strategy

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course description
Successful firms regard operations as a source of competitive advantage, and think strategically about operations. Operations constitute a value chain beginning with product/service design, which include process design, suppliers, manufacturing, distribution, customer service, and environmental impact. The course provides an understanding of the

value chain, the strategic context in which the operations take place and the various considerations that have to be made when making strategic decisions for the organisation.

Course objectives

This module aims to develop an understanding of operations strategies used to develop all aspects of the value chain for competitive advantage. Participants will be equipped with the skills of strategic thinking. It provides them with a knowledge and understanding of business policy and strategy.

Course content

- Introduction to Business and operations strategy (5 hours)
- Structural analysis of the industry and competitive environment (6 hours)
- Competitive advantage and competitive positioning (4 hours)
- Operations strategy formulation (6hours)
- Analysing resources and capabilities/ competences (4 hours)
- Make vs buy and supply network strategy (6 hours)
- Strategic outsourcing (4 hours)
- Managing change (6 hours)
- The role of leadership (4 hours)

Methods of course delivery:

The teaching of students will be conducted through lectures, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading.

Method of assessment

Assessment will be done through coursework which will include assignments, project work, and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments and project presentations 15%, and Practical Work 25%.

Reading list/References

1. De Witt, B. , Ronn Meyer 2010. Strategy: Process, Content and Context. An International Perspective. 4th Edition. Cengage Learning EMEA, London.
2. Thomas L. Wheelen and J. David Huger. *Strategic Management and Business Policy*, 8th edition ,prentice Hall
3. Fred R. David. *Strategic Management*, 7th edition.
4. Ned Ritson, 2008, *Strategic Management*, Ventus Publishing APS.
5. Anders Drejer, *Strategic Management and Core Competences: Theory and Applications*, 2002, Greenwood Publishing Group. Inc

MEC7236: Advanced Manufacturing Materials:

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	**PT**	**TH**	**CH**	**WTM**	**WEM**	**WCM**	**CU**
45	00	00	45	100	60	40	3

Course Description

Engineers are often involved in materials selection decisions, which necessitates that they have some familiarity with the general properties and characteristics of a wide variety of materials. In addition, knowledge of their fabrication characteristics is vital. In most cases, also, the engineer will have access to data bases containing property values for a large number of materials. This course introduces the properties, characteristics and applications of advanced materials (ceramics, metals, polymers and composites). Methods of optimization of material properties for some alloys, as a guide in material selection, will also be introduced.

Course Objective

The aims of this course are to:

§ Introduce the properties and application of various advanced materials and alloys

§ Guide students through the process of optimization of material properties within an alloy system, and hence material selection.

Learning Outcomes

At the end of this course, students should be able to:

- Understand the properties/characteristics
- The application limitations of advanced engineering materials
- Broaden their knowledge of engineering materials
- Make better assessment of materials for various applications

Course Content

- Properties of ferrous alloys and their application as engineering materials (4 hours)
- Compositions, Properties, and typical Applications for Austenitic, Ferritic, Martensitic, and Precipitation-Hardenable Stainless Steels (4 hours)
- Non ferrous alloys: properties and applications (5 hours)
- Super alloys: properties, applications and compositions (4 hours)
- Property optimization, materials selection and specification. (4 hours)
- Biomaterials: Properties and application (4 hours)
- Advanced ceramics: Characteristics and application (4 hours)
- Advanced polymeric materials: properties, applications e.g. LCD polymers (4 hours)
- Crystallization, melting and glass transition phenomena in polymers (4 hours)
- Composites: properties, Applications, fabrication and joining methods (4 hours)
- Nano materials: Properties, fabrication and applications (4 hours)

Delivery Method
The teaching will be conducted through lectures, case studies and group discussions among the students. The lecture material will be availed to the students in advance to enable them have prior reading.

Assessment Method
Assessment will be done through coursework which will include assignments, class room tests and a written examination. Course work will carry a total of 40% and written examination carries 60%.

References

1) Callister W.D (2005). Fundamentals of Materials Science and Engineering, an Integrated Approach. 2nd Ed. John Wiley & Sons. ISBN: 0-471-47014-7
2) Groover, M.P (2007). Fundamentals of Modern Manufacturing: Materials, Processes, and Systems. 2nd Ed. John Wiley & Sons, Inc. ISBN-13: 978-0-471-74485-6
3) Kalpakjian, S. Schmid, S. (2006). Manufacturing Engineering and Technology. 5th Ed. Pearson Education Inc. ISBN: 0-13-148965-8
4) Degarmo, E.P., Black, J.T and Kohser, R.A. (2003). Materials and Processes in Manufacturing. 9th Ed. John Wiley & Sons, Inc. ISBN: 0-471-03306-5
5) Smallman R.E and Bishop R. J (1999). Modern Physical Metallurgy and Materials Engineering: Science, Process and Applications, 6th Ed. Butterworth Heinemann ISBN: O- 7506 4564- 4
6) Mazumdar S. K (2002). Composites Manufacturing: Materials, Product, and Process Engineering, CRC Press LLC. ISBN 0-8493-0585-3

MEC7115: Computer Aided Manufacturing

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course Description
In the past decades, Computer Aided Design (CAD) was developed to streamline and make the drafting functions more efficient, flexible and easy to manage. Computer Aided Manufacturing (CAM) in turn has developed to eliminate bottlenecks between the design and manufacturing stage. Traditional clerical functions have been integrated into a comprehensive computer controlled systems, including the generation of bills of materials, controlling the machine tools, manufacturing process planning, and machine cell control. CAM results in lower production and product costs, and increased business profitability.

The Course Objectives
This course introduces the students to CAM, CAD/CAM software and machine tool hardware. The benefits of CAM such as automation reliability, reduced production costs, seamless design and production process integration, increased product design and manufacturing flexibility, rapid prototyping, production planning, production inventory

management, and the ongoing CAM advances to fully automate the production are explored. CAM is expensive, with incompatibilities caused by a non-existent global standard; factors a student is made aware of.

Learning Outcomes

The students are expected to learn how to:
1) Generate G-code from CAD drawings
2) Generate production process layouts based on part family analyses
3) Use CAM software (CAD is a prerequisite)
4) Generate part manufacturing programs in CAM and control of CNC machines

Detailed Course Content

- NC Machine programming (EMC2) (6 hours)
- Components of a NC system, NC coordinate systems,
- NC path control systems, NC position types,
- NC motion control types, Precision in positioning,
- NC part programming techniques, Applications of numerical control

Computer integrated manufacturing (10 hours)

- Using CATIA for part design and functional analysis,
- Using CATIA for part programming
- Part design and part programme generation
- Product manufacturing simulation and machining analysis

Manufacturing planning and control systems (4 hours)

Group technology [2, 3] (8 hours)

- Design attributes, Part manufacturing attributes,
- Key features of group technology, applications,
- Part Families and part family formation,
- Part family coding, Selection of classification and coding systems,
- Benefits of group technology,

Cellular manufacturing [2, 4] (6 hours)

- Cell design, Evaluation of cell design decisions,
- Cell formation approaches, Rank order clustering algorithm,
- Similarity coefficient-based approaches, Single-linkage cluster analysis
- Exceptional parts and bottleneck machines, Cell design evaluation

Project (52 hours)

Course delivery and Learning Pattern

Lectures will be conducted to cover the course material. The course content will be presented in slide format, in sufficient detail to constitute class notes. The slides will be provided in advance of the lectures. Some material will be covered in class and students will be informed when expected to make notes. Demonstrations of the concepts covered in some lectures, simulations and programs will be used to reinforce the learning.

Course Assessment

Course assessment will be through 2 assignments, a test, 2 individual assignments, and examinations, which will constitute:

• Course work assignments 20%
• Test 20%
• Project Labs 60%

References

[1] Dessault Systemmes CATIA V5R17, (2006) "Computer aided tri-dimensional application -NC Machining".
[2] Groover M.P,(2007) "Fundamentals of modern manufacturing: Materials, processes, and systems", *John Wiley and Sons, Inc*, .
[3] Tien Chien Chang, Richard A. Wysk, and Hsu Pin Wang, (2008) "Computer-aided manufacturing",
Pearson Education, ISBN 9788131721643.
[4] Programming with MATLAB, "MATLAB-The Language of Technical Computing", *http://www.mathworks/products/matlab*.

TID7202 : Logistics Engineering

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	**PT**	**TH**	**CH**	**WTM**	**WEM**	**WCM**	**CU**
45	00	00	45	100	60	40	3

Course description

Logistics is about the purchasing, transport, storage, distribution, warehousing of raw materials, semi-finished/work-in-process goods and finished goods. This course will provide knowledge to students on the fundamentals, modelling and practice of this function in an organization.

Course objectives:

To show an overview of the general area of logistics, its nature, scope, and process; a critical examination of logistics management functions and the interrelationships among strategic support and operational logistics

Learning Outcome

By the end of this course the students should be able to;

- To manage the flow of goods, information and other resources, including energy and people, between the point of origin and the point of consumption in order to meet the requirements of consumers (frequently, and originally for military organizations).
- To involve the integration of information, transportation, inventory, warehousing, material-handling, and packaging.

Course content

Scope and elements in logistics, logistics planning, logistics in the systems life cycle, logistics engineering **(6 hours)**

Measures of logistics; system feasibility analysis, chain supply management, Procurement systems, system operational requirements **(6 hours)**
Logistics in design, manufacturing and support **(3 hours)**
Inventory management- **(6 hours)**
Maintenance and support concept, technical performance measures, functional analysis, allocation of requirements, synthesis, analysis and design optimization **(9 hours)**
Supportability analysis process, methods, tools and applications **(3 hours)**

Course delivery method

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Assessment method

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Reading list/references

1. Blanchard, Benjamin S (2004), *Logistics Engineering and Management,* 6th – International Edition, Prentice Hall Inc.
2. Paul Cousins and Richard Lamming and Ben Lawson Brian Square. (2008). Trentice Hall.
3. Martin Christopher (2005). Logistics and Supply Chain Mangement. Creating Value Adding Networks. Prentice Hall.
4. Leutz Prauss,(2005) The Green Multiplier. A Study of Environmental Protection and Supply Chain. . Antonn Rauss Limited, Palgrave Macmillan.
5. Logistics Engineering handbook, (2008)G Don Taylor Editor, CRC Press 2008, ISBN 13: 978-0-8493-3053-7, Amazon.com

MEC7237 : Asset Management

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course Description

The challenge for process improvement and maintenance engineering is to develop the most effective and at the same time efficient strategy for managing the performance, capability and condition of plant & equipment and other organisational assets in order to meet commercial, operational , health safety and environmental requirements. The asset management module provides a comprehensive overview of asset maintenance concepts, analyses and improvement strategies.

Course objectives:

- To give students a comprehensive overview of the field of maintenance and process improvement for various organisational assets both from a management and technical perspective.
- To give students the confidence and capability to conduct further work or research in this important field.
- Enable students to work in groups to improve problem-solving skills using computation, and to apply fact-based analyses to design maintenance and process improvement strategies and plans.

Learning Outcome

At the end of the course the students are required to know the following;

- Understand the steps involved in specifying equipment at the time of purchase and the importance of an ongoing reliability and condition monitoring program to ensure that performance is maintained and both condition and risk are appropriately identified and managed.
- Understand the various methodologies used in industry to estimate the level of reliability and remaining life of a critical component at a certain point in time, using statistical and mathematical techniques where appropriate.
- Understand the principle of Reliability-centered Maintenance (RCM), TPM, CMMS, and FMECA.
- Understand the major mechanisms involved in component and system degradation.
- Be able to conduct a reliability study and to make recommendations with respect to the maintenance plan and ongoing reliability program.

Course delivery method

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques

Assessment Method

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Course Content:

The meaning and value of maintenance (3 hours)
Overview of damage mechanisms and their maintenance burden, evaluation of equipment function reduction loss (6hours)
Failure modes, effects and critical analysis and failure prevention (6 hours)
Maintenance planning Condition based maintenance, condition monitoring techniques (4 hours)
Maintainability and reliability assessment, organizing for maintenance records: equipment record, inspection report check lists (6 hours)
Inspection schedules and maintenance cost records (6 hours)
Machine tools maintenance; general recommendations, insulation maintenance, bearing Maintenance, commutator and brushes maintenance (3 hours)
Maintenance and repair of electronic equipment techniques and procedures (3 hours)
Maintenance logistics (spare parts management) (2 hours)
Maintenance outsourcing (2 hours)
Computerization of the maintenance system (4 hours)

Reading list/references

1. Larry Bush, Maintenance Policy and Procedures Manual 2nd Edition Published by www.BIN95.com 2008 ESBN: E43-851B-1b34-10Q5
2. Carlo Scodanibbio World Class OEE calculation use to meet your Total Productive Maintenance Objectives, World Class OEE - A TPM Tool, Published by www.bin95.com 2008/09
3. Mike Sondalini. From Preventive Maintenance to Root Cause.
4. Mike Sondalini. The Japanese Path to Maintenance Excellence. The e-book that tells you how the Japanese destroy maintenance
5. Mike Sondalini CMMS Secrets,

MEC7238: Automation

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course Description

Many of the emerging products and machine systems on the market now come with a high level of automation, embedded with control systems that integrate information and communications technology, intelligent mechano-electronic sensors, micro-processor controllers, and powerful deduction algorithms and integrate a diverse range of parameter sensors. In Automation Engineering, the integrations of applications of applied mathematics, information technology, computer engineering, electrical and electronics engineering into mechanical systems design, and control to create these autonomous or semiautonomous intelligent mechanical systems are explored, and equip the student with thenecessary technical skills to support automated systems.

Course Objectives

In this course, the objective is to provide the skills necessary to support, design and generate an automated or semi-automated unit system that can be integrated into a wider process of other existing or future automated systems. This also aims to produce a problems solving engineer using a process-centric pedagogical approach that puts the student hands-on in the practical applications of the theories covered, and with an individual centred research approach to solving set problems.

Learning Outcomes

The students will cover course material on applied mathematical methods, computer architecture and systems programming, mechanical systems design and simulation, mechanoelectronic system controller design integration, through:

- Knowing applied linear algebra and advanced computer programming methods, and numerical methods for deducing information from large systems of variables.
- Design, analyse and generate efficient software algorithms that interface the computer with sensors and peripheral component systems.
- Design mechano-electronic systems to sense environment parameters of interest and their transduction, conversion and fusion into usable digital formats for control.
- Design, simulation and analysis of multibody dynamic mechanical systems.
- Instructions and Learning Pattern

Systems that implement these principles will be designed in advance, so that the lectures focus on introducing the theoretical principles underlying the systems design. The theory will be reinforced with a practical approach to implement non-existing modules of the theory, and to forge a problem solving ethic in the students. Materials from journal papers on the topics of discussion will be used to create awareness of the diverse approaches used to solve a problem. Simulations and algorithm implementations will also be used.

Course Details

Applied advanced mathematics and systems analysis (9 hours)
Introduction to applied linear algebra , Numerical methods and algorithms [2],Applied differential equations (shock wave analysis for complex flow systems)

Computer systems applications (9 hours)
Computer organisation, hardware/software interface, Advanced computer programming, (C,C++,C#), Software development, simulations and analysis, Computer hardware systems and realtime system control, Embedded systems for dedicated system control, Computer interfaces and device drivers

Advanced automation, robotic systems, analysis and control (9 hours)
Introductory robotics and industrial robots, Manipulator design and kinematics analysis, Design and analysis of multibody dynamics systems, Robot programming, motion and control algorithms, Robot task generation, task based autonomous system modelling, design and analysis, Economic justification and robot selection

Systems engineering and artificial intelligence of mechanical systems (9 hours)
Image acquisition and analysis, Image processing and visual servoing, Visual feedback systems for robotic systems control, Signal processing, Environment sensing, sensor design and data fusion for robotic control, Multiple system interaction and control, Case study of object tracking

Electronics principles for component design and micro-controller programming (9 hours)
Fundamentals of diodes, transistors, Digital logic timers and counters, Electronic systems design and simulation, Applied electronics for computer periphery systems design, Historical background of PLCs, PCs vs PLC, PLC parts, Ladder Logic diagrams

References

[1] Gilbert Strang, "Introduction to linear algebra", Wellesley Cambridge Press, (2009) ISBN 978-09802327-45.
[2] William H. Press, Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery, "Numerical recipes in C++ - The art of scientific computing", Cambridge University Press, (2007) ISBN 0-521-75033-4.
[3] David A. Patterson and John L. Hennessy, "Computer organisation and design. the hardware/software interface", Elsevier Morgan Kaufmann, (2005) Third Ed.
[4] Steve Oualline, "Practical C programming", O'Reilly, 1997.
[5] John J. Craig, "Introduction ot robotics mechanics and control", Pearson Prentice Hall, 2005.
[6] Tsuneo Yoshikawa, "Foundations of robotics analysis and control", The MIT Press, 1990.
[7] Groover M.P, "Fundamentals of modern manufacturing: Materials, processes, and systems", John Wiley and Sons, Inc, 2007.
[8] Wikipaedia, "Programmable logic controller", http://en.wikipedia.org/wiki/Programmable-logic-controller.
[9] PLC Programming Org, "Plc programming, tutorial, training, hints and tips", http://www.plcprogramming.org.

MEC7234: Manufacturing Modelling and Analysis

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course Description

This course covers a broad range of techniques and tools relevant to the design, analysis, development, implementation, operation and control of modern manufacturing systems. A significant portion of the coursework involves a group project with industry.

Course objectives

To present the knowledge of key drivers of manufacturing system performance, how lead time reduction can drive improvements throughout the enterprise, and familiarity with common techniques and tools for manufacturing system analysis. It also presents how to conduct a manufacturing improvement project while working in a team environment.

Learning Outcomes

At the end of the course, students should be able to:

1. Describe the basics about design, control, and planning of discrete manufacturing systems
2. Analyze and design manufacturing systems by quantitative models
3. Carry out procedures that can lead to improvements in a malfunctioning manufacturing systems

Course Content

Introduction to modern manufacturing strategy and the importance of Quick Response manufacturing	(3hours)
Implementing quick response in production.	(2 hours)
Structured methodology to conduct a manufacturing improvement project.	(3hours)
Creating a goals document.	(2 hours)
Impact of lot sizes and capacity planning.	(2 hours)
MRP in the modern manufacturing context.	(4 hours)
Supplier and Customer strategies.	(3 hours)
Rapid new product introduction.	(2 hours)
Management mindset and performance measures.	(2 hours)
Tools for manufacturing system analysis.	(4 hours)
Manufacturing process simulation and analysis	(14 hours)
Steps to implementing changes and improvements.	(4 hours)

Course delivery

In this course, students are instructed on methods of treating quantitative models for design, redesign, control and planning of discrete manufacturing systems. Assignments have a research character and explore the state of the art on those topics. During this part, the course provides experience with teamwork, specifically, participating in a team-based real-world project.

Method of Assessment

Assessment will be done through coursework which will include assignments, classroom and home tests, project work and presentations project presentations and the final project report, and a written examination. Coursework will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into: Assignments 5%,, Tests 10% and Project work 25%.

Reading list/references

1. Bin Wu Manufacturing Systems Design and Analysis: Context and Techniques. Springer; 2nd Revised edition edition (30 Sep 1994) ISBN-10: 9780412581403
2. Guy L. Curry and Richard M. Feldman Manufacturing Systems Modeling and Analysis. Second Edition. Springer-Verlag: ISBN # 978-3-642-16617-4

3. Wallace Hopp, Mark Spearman (2007) Factory Physics: Foundations of Manufacturing Management. McGraw-Hill/Irwin; 3 edition ISBN-10: 0072824034
4. Guy L. Curry and Richard M. Feldman (2010) Manufacturing Systems Modeling and Analysis Springer; 2nd Edition. edition eBook. | ISBN: 3642166172

TID 8102: Safety, Health and Environment Management

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course Description

This multidisciplinary course provides specialized advanced training for graduates or occupational health and safety practitioners with an emphasis on risk and safety management and occupational injury, disease prevention and environmental protection. This course has an emphasis on practical and theoretical occupational health and safety (OHS) skills with a strong mix of science and technical practical and theoretical knowledge in the core discipline areas of risk management and accident prevention, ergonomics, occupational hygiene, health and safety economics and management, and compensation and injury management. There is an emphasis on industry based assessment and the development of practical skills.

Course Objectives

This unit covers legislative concepts underpinning contemporary occupational health and safety in occupational health and safety management systems by the application of key managerial principles, functions and skills within an organization. The unit also covers accident investigation, safety management plans and environment protection.

Learning Objectives

The course on Occupational Health, Safety and Environment prepares graduates for work in the preparation and implementation of occupational health and safety programs at the workplace. In many cases, students will be in positions of managerial or professional responsibility, through which they are required to develop policies and strategies in response to the occupational health and safety needs of their organizations.

As well as extending students' skills in raising awareness of occupational health and safety issues and dealing with risks and dangers in the workplace, the program also aims to encourage the desire to promote the health, safety and well-being of others and to help students develop a problem-solving approach to occupational health and safety issues.

Course Content

Introduction to health, safety and environmental issues (2 hours)
Scientific understanding of causes and possible future approaches to control of the major environmental health problems in industrialized and developing countries (9 hours).
Effects of environmental pollutants on human bodies; physical, chemical, and biological agents of environmental contamination; solid and hazardous waste; susceptible populations; biomarkers and risk analysis; the scientific basis for policy decisions; and emerging global

environmental health problems. (9 hours)

Human-environment interactions: specifically, environmental factors that influence health i.e. physical, chemical and biological stressors and pollutants that affect the health and wellbeing of individuals and populations. (3 hours)

The role of government in environmental health management. (9 hours)

Hazard identification, dose-response assessment, exposure assessment and risk characterization. Risk assessment and evaluation of hazards; selected examples. Hazard analysis and risk criteria.
Principles and conduct of environmental health risk assessments. (4 hours)

Occupational health and safety. Liability of the legislation and regulations, and the role of safety policy and organisation. Other topics include equal opportunity laws, workers compensation, common law liability, and specific legal aspects relating to women in the paid workforce. (9 hours)

Delivery Method

There delivery will be in form of lectures and assignments that have a research character and explore the state of the art on those topics. During this part, the course provides experience with teamwork, specifically, participating in a team-based real-world project.

Method of Assessment

Class topics cover the basics of managing workplace health and safety. Students learn how to design, evaluate and implement programs that promote safer work environments. They are also taught how to handle emergency situations and, when possible, how to prevent them from occurring.

Reading list/references

1. Richard Welford, Editor,(2007), Corporate Environmental Management Systems and Strategies, Earth Scan, 2nd Edition.
2. William Martin, James Walters, (2010) Safety and Health Essentials for Small Businesses, Butterworth Heinemann.
3. Ken Whitelaw, ISO 14001,(2004) Environmental Systems Handbook, Butterworth Heinemann,
4. A. Edwards,(2003), ISO 14001, Environmental Certification Step by Step, Butterworth Heinemann.
5. William Martin and James Walters. 2001. Safety and Health Essentials: Compliance for Small Businesses. Butterworth and Heinemann.
6. James Roughton and James Mercurio. 2002. Developing an Effective Safety Culture: A Leadership Approach. Butterworth and Heinemann.

7. Sarkis, Joseph; Cordeiro, James J.; Vazquez Brust, Diego (Eds.). 2010. Facilitating Sustainable Innovation through Collaboration: A Multi-Stakeholder Perspective. Springer
8. Krozer, Yoram. 2008. Innovations and the Environment. Springer

TID8104: Lifecycle Analysis and Sustainability

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course Description

This is the investigation and valuation of the environmental impacts of a given product or service caused or necessitated by its existence or the total cost of ownership over the life of an asset, also commonly referred to as "cradle to grave" or "womb to tomb"

Course objectives:

This course offers understanding in life cycle analysis for cradle to grave of products, and how sustainable this tool can be.

Learning outcomes:

By the end of this course the student should be able;

- Analyze the sustainability of product and service developments.
- To apply life cycle analysis tool to any product and service.
- To make an impact analysis of the products lifecycle of products to the environment.
- To cost the product or services at every process, and be able to make decisions using lifecycle tools and management strategies**.**

Course content

i. Introduction to life cycle analysis and sustainability (3 hours)
ii. Sustainability in product and service development (4 hours)
iii. Eco-efficiency, resource efficiency, life-cycle processes and modelling, input-output analysis (9 hours)
iv. Life-cycle environmental assessment (6 hours)
v. Value chains, life-cycle costs, activity-based costing, risks and uncertainties(9 hours)
vi. Decision making tools, and product life-cycle management strategies and cases (12 hours)

Course delivery method:
The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques

Method of assessment
Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Reading list/references

1. Wolter J. Fabrycky, Benjamin S. Blachard; (2005) Life-Cycle Cost and Economic Analysis. Prentice Hall International Series in Industrial and Systems Engineering)
2. Takata, Shozo; Umeda, Yasushi (Eds.). (2007). Advances in Life Cycle Engineering for Sustainable Manufacturing Businesses. Springer.
3. Brissaud, Daniel; Tichkiewitch, Serge; Zwolinski, Peggy (Eds.). 2006. Innovation in Life Cycle Engineering and Sustainable Development. Springer

TID 8105: Advanced Product Design and Development

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course description

This course requires that students get to know the basic procedure of designing products and services. This entails that students learn methods of transforming clients' wants into specifications to enable the design of products, taking into mind restrictions of costs and space.

Course objectives:

After completing this course the students should understand and be able to plan and implement the technical aspects of product development within a company.

Learning outcomes:

The students should be able to know clearly the following;
i) Be able to get product specifications after discussions with the customers
ii) Be able to get concepts from scratch and design a product using the specified procedures of product development.

iii) Be able to cost for every stage of the product development, and look out for ways of minimizing them.

Methods of course delivery:

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques

Method of assessment

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Case studies and product design challenges will be used in the course. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical Work 25%.

Course content

i. Introduction to product design (4 hours),
ii. The product design and development process (6 hours),
iii. Product life-cycle. Product specifications, Concept generation, selection and testing (10 hours)
iv. Product architecture, Industrial Design and modelling (10 hours),
v. Prototyping, Product development economics (10 hours).

Basic reading list/references

1. Grossman I. E, global optimization in Engineering Design (non convex Optimization and its application), Springer, 1st Edition, 1996
2. Industrial Engineering Book; Jorcad.com 2006-2009
3. Process oriented analysis; Design and optimization of industrial production systems, Meyer. Urs B, Creux Simone E. Weber Mann, Audrea K. 2006.

MECXXX: Applied Linear Algebra

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PT	TH	CH	WTM	WEM	WCM	CU
45	00	00	45	100	60	40	3

Course description

The course will lay down the basic concepts and techniques of linear algebra needed for subsequent study. At the same time, it will provide an appreciation of the wide application of this discipline within the scientific field. The course will require development of theoretical results. Proofs and consequences of such results will require the use of mathematical rigour, algebraic manipulation, geometry and numerics.

Course objectives

A goal of the course is to provide insight into how linear algebra theorems and results can be applied in everyday life.

Course outcomes

- Comprehend vector spaces (subspaces).
- Understand fundamental properties of matrices including inverse matrices, eigenvalues and linear transformations.
- Be able to solve linear systems of equations.
- Have an insight into the applicability of linear algebra.

Teaching and Learning Pattern

- The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Assessment Method

- Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical/project Work 25%.

Course content

I.	Introduction to vectors	2 hours
II.	Solving linear equations	5 hours
III.	Vector spaces and subspaces	5 hours
IV.	Orthogonality	5 hours
V.	Determinants	5 hours

VI. Eigen values and Eigen vectors 5 hours
VII. Linear transformations 5 hours
VIII. Numerical linear algebra 8 hours
IX. Complex vectors and matrices 5 hours

References

[1] Strang, Gilbert. *Introduction to Linear Algebra*. 4th ed. Wellesley, MA: Wellesley-Cambridge Press, February 2009. ISBN: 9780980232714.

[2] Thomas S. Shores, 2007 Applied linear Algebra and matrix analysis. Springer, ISBN1-10-9780387331959

[3] Carl. D Meyer, 2001 Matrix analysis and applied linear algebra. Springer ISBN-13-978-0898714548

TID 8103: Project Work

Hours per semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	**PT**	**TH**	**CH**	**WTM**	**WEM**	**WCM**	**CU**
0	0	0	150	100	60	40	10

Short Description

This course provides students with the opportunity to build upon the knowledge and skills he/she has acquired during the basic and advanced course in an industrial setting. The project work is conducted in collaboration with companies and industry.

Course Objectives:

The objective of the course is to further collaboration between the university and industry and in so doing enable the application of the principles and practices of innovation and entrepreneurship to industry.

Learning Outcomes:

By the end of this course the student should be able to;

- Identify different opportunities to apply theoretical knowledge and principles to a given problem faced by industry
- Carry out an analysis of problems faced by industry or group of industries using well-known techniques
- Propose and analyze the impact of different solutions to problems faced by industry
- Produce a detailed report of the project work

Methods of Course Delivery:

The project work will carried out in groups of three to five students. Students will be expected to assemble into a group which has to be approved by the course coordinator. The project must be connected to the student's specialization and must of direct interest to an industry or group of industries.

The steps to be followed in the conduct of project work will in general take the following form:

- Step 1:Proposals of projects are prepared by the course academic staff in consultation with industry
- Step 2: Students assemble into groups and select a project from the list of provided projects
- Step 3: Projects are assigned to students by the course coordinator
- Step 4: Students undertake the project under the supervision of academic staff
- Step 5: Students prepare a report and a PowerPoint presentation of their findings

Method of assessment

The students' work will be assessed on the basis of the innovativeness of the proposals made in respect of the industry that is interested in the project. The project report will be assessed as follows: Internal Examiner 40%, External Examiner 60%.

Basic reading list/references

This will depend on the topic of the chosen research project.

13. PROGRAMME REGULATIONS

General Regulations
The general Master's degree regulations of Makerere University shall apply.

Course Assessment
The courses offered in the programme will be assessed on a course by course basis and will comprise coursework and project assignments, tests and examinations. The details are specified for each course in Section 11.

Grading of Courses
Each course shall be graded out of a maximum of 100 marks and assigned appropriate letter grades and grade points as follows:

Table 14: Course Grading

Marks%	Letter Grade	Grade points	Interpretation
90-100	A+	5.0	Exceptional
80-89	A	5.0	Excellent
75-79	B+	4.5	Very good
70-74	B	4.0	Good
65-69	C+	3.5	Fairy good
60-64	C	3.0	Pass
55-59	D+	2.5	Marginal pass
50-54	D	2.0	Clear fail
45-49	E	1.5	Bad fail
40-45	E-	1.0	Qualified fail
Below 40	F	0	Qualified fail

CALCULATION OF THE CUMULATIVE GRADE POINT AVERAGE (CGPA)
The Cumulative Grade Point Average at a given time shall be obtained by:

$$CGPA = \frac{\sum_{i=1}^{n}(GP_i * CU_i)}{\sum_{i=1}^{n} CU_i}$$

where , GP_i is the Grade Point score of a particular course *i*;
CU_i is the number of Credit Units of course *i*;
and *n* is the number of courses so far done.

i) Multiplying the grade point obtained in each Course by the Credit Units assigned to the Course to arrive at the Weighted Score for the Course.
ii) Adding together the Weighted Scores for all the Courses taken up to that time.
iii) Dividing the Total Weighted Score by the total number of Credit Units taken up to that time.

13.1 Retaking a course or courses

i) A student shall retake a Course or Courses when next offered again in order to obtain at least the Pass Mark (60%) if he/she had failed during the First Assessment in the Course or Courses.

ii) A student who has failed to obtain at least the Pass Mark (60%) during the Second Assessment in the same Course or Courses he/she has retaken shall receive a warning.

iii) A student may retake a Course or Courses when next offered again in order to improve his/her Pass Grade(s) if the Pass Grade(s) got at the first Assessment in the Course or Courses were low. A student who fails to attain higher marks after retaking to improve, the examination results of the first sitting are recorded on the transcript and should not be recorded as Retake.

iv) Where students miss to sit examinations for justified reasons; they should not be recorded as those who retake when they sit the examinations when next offered.

While retaking a Course or Courses, a student shall: -

a. Attend all the prescribed lectures/ tutorials/ Practical's/Fieldwork in the Course or Courses;
b. Satisfy all the requirements for the Coursework Component in the Course or Courses; and
c. Sit for the University Examinations in the Course or Courses.
d. A student shall not be allowed to accumulate more than five (5) Retake Courses at a time. Students are required to register for retake course(s) first before registering for new courses offered in that semester and the retake courses should fit into the approved normal load so as to avoid timetable clashes.
e. A final year student whose final Examination Results has already been approved by the School Board and has qualified for the Award of a Degree in M.Sc. Mech Eng, shall not be permitted to retake any Course or Courses.
f. When a student has retaken a course the better of the two Grades he/she has obtained in that course shall be used in the computation of his/her cumulative Grade Average (CGPA).
g. Whenever a Course or Courses has/have been retaken, the Academic Transcript shall indicate so, accordingly.
h. Students who have a course(s) to retake and these Course(s) fall beyond the set normal semester load for their Academic Programmes shall pay tuition fees for any Course/Courses to be retaken. Besides, such students also pay the re-examination fees per Course retaken as well as the Registration Fees.

13.2 Progression

Normal Progress

Normal Progress shall occur when a student has passed the Assessments in all the Courses he/she had registered for in a particular Semester and not when he/she has passed the Assessments in the Core Courses only.

Probationary Progress

A student who has obtained the Cumulative Grade Point Average (CGPA) of less than 3.0 shall be placed on Probation. Such a student shall be allowed to progress to the next Semester/Academic Year but shall still retake the Course(s) he/she had failed later on and obtain at least the Pass Mark (60%).

13.3 Certificate of due performance

(i) A student who fails to honour the deadline set for handing in an assignment without justifiable reasons shall receive a score of a zero or fail grade in that assignment.

(ii) A student who does not have coursework marks shall be denied the Certificate of Due Performance and will not be allowed to sit the University Examinations.

Conceded Pass

A "Conceded Pass" will be granted for a course in which a final year candidate is within five marks of a pass mark in the course assessment. The pass is conceded on the basis that the student's overall performance in other courses for the programme has been sufficiently strong to counter the deficient percentage in that particular course.

The circumstances warranting a conceded pass shall avail as stipulated in the graduate training and research handbook 2009.

13.4 Discontinuation

When a student accumulates three consecutive probations based on CGPA he/she shall be discontinued.

i) A student who has failed to obtain at least the Pass Mark (60%) during the Third Assessment in the same Course or Courses he/she had retaken shall be discontinued from his/her studies at the University.

ii) A student who has overstayed in an Academic Programme by more than Two (2) Years shall be discontinued from his/her studies at the University.

13.5 Dissertation

The dissertations shall conform to the standing guidelines and regulations of the University on higher degrees. In addition, the following shall also apply:

i) A candidate shall not be allowed to formally start on research work unless he/she has passed at least 10 courses.

ii) A candidate shall submit a research proposal to the Faculty Higher Degrees Committee before the end of first semester of second year of study.

iii) The candidate shall conduct research during the second semester of the second year of study.

iv) The candidate shall hand in three hard copies and one soft copy of the dissertation by the end of the second year.

13.6 Passing a dissertation

To pass a dissertation, the candidate shall satisfy the examiners in both the written report and viva voce.

REVISED DISSERTATION

A candidate who fails to satisfy examiners shall re-submit a revised dissertation within six months after notification.

13.7 Graduation requirements

The degree of M.Sc. (Mechanical Engineering) shall be awarded to a candidate who fulfils both conditions below:-

i) Accumulated a minimum of 60 credit units.
ii) Passed the dissertation.

13.8 Quality assurance

The quality assurance practices like the other programmes in the CEDAT in particular and Makerere University in general shall apply. A student will be required to attend at least 70% of the lectures given in a course, do and pass all the coursework assignments, tests and laboratory exercises before he/she can sit for a written examination. Also the performance of the assigned lecturers to teach these students shall be monitored closely to ensure they comply with the curriculum requirements. This will be partly achieved through giving the students assessment forms to assess their lecturers on the content taught, mode of delivery, self-explanation and appearing for lectures.

13.9 Classification of award

The degree of Masters of Science in Mechanical Engineering will be awarded to a student who fulfils all the requirements for the programme or upon attaining a total of 60 credits for graduation and conducts and passes a Dissertation arising out of research work.

14. RESOURCES

14.1 Human resources

The capacity to run the programme exists within the Department of Mechanical Engineering. Staff from School of Engineering, Engineering Maths and School of Economics and Management in Makerere University and from elsewhere will participate in the teaching, industrial excursions and supervision of students. The Department of Mechanical has over 10 with PhD’s. We expect three more members of staff to graduate in 2012 and two more in 2013/14.

Table 15: Academic Staff

STATUS						Current Teaching Load	Proposed Teaching Load	Total Load
Full time Part Time	Name	Highest Qualification	Area of specialisation	Teaching Supervisory Experience Rank	Current Number of students supervised			
Full-Time	M.E Okure	PhD	Energy Engineering and Mechanical Systems Dynamics and Control	Assoc. Prof.		3	3	6
Full-Time	J. K.Byaruhanga	PhD	Material Engineering, Maintenance Engineering	Assoc. Prof.	4 PhD, 3 Msc.	8	4	12
Full-Time	Adam M Sebbit	PhD	Energy and Materials Engineering	Senior Lecturer	3 Phd, 3 Msc.	3	3	6
Full-Time	S.B.Kucel	PhD	Mechanical Engineering, Energy Engineering, ICT	Senior Lecturer	3 Phd, 5 Msc	3	4	7
Full-Time	B. Kariko-Buhwezi	PhD	Production and Manufacturing Engineering	Senior Lecturer	2	8	3	11
Full-Time	J.B Kirabira	Phd	Material Engineering, Management and Product development	Senior Lecturer	2	7	3	10
Full-Time	J.I Okware	Phd	Production and manufacturing	Lecturer	0	0	3	3
Full-Time	P. Olupot	PhD	Materials and production Engineering	Lecturer	0	4	6	10
Full time	Peter. Mulamba	PhD	Agricultural and Bioscience Engineering.	Lecturer	0	0	3	3

			Environmental Engineering					
Full-Time	Betty Nabuuma	PhD	Engineering Management	Lecturer	2	6	3	9
Full-Time	Samuel Okedi	PhD	Manufacturing and control Engineering	Assistant Lecturer	1	6	3	9
Temporary	Al-Mas Sendegeya	Phd	Department of Electrical and Computer Engineering : Power systems and Renewable Energy	Lecturer	2	6	3	9
Contract	Eng Peter Okidi-Lating	PhD	Department of Engineering Math Engineering Maths	Lecturer	3	3	6	9

14.2 Facilities

Facility	Components	Users
Materials laboratory	Strength of Materials	Graduate
	Material Science	Graduate
	Absorption Spectro Photometer	Graduate
Thermodynamic	Gas chromatography	Graduate
	Gasifier (two modes)	Graduate
	Multiple Heat Exchangers	Graduate
	Stirling Engine	Graduate
Workshop	Machine shop/ CNC Machines	General
	Fabrication shop	General
	Metrology lab	General
Fluid laboratory	Fluid flows and modelling	Graduate
	Trnsys (software and hardware)	Graduate
Energy Soft ware	LEAP Energy Modelling Tool	Graduate
	Engineering Equation Solver	Graduate

I EXPECTED INCOME

Tuition Fees

Total Admission Number	10
Number of semesters	2
Amount Payable per Student per semester	2,850,000/=
Total Amount per Semester	**28,500,000/=**
Total Amount per Year	**57,000,000 /=**

II DISTRIBUTION

College (61%) 34,770,000/=

Central Activities (39%) 22,230,000/=

Total **57,000,000/=**

B DETAILS OF PROGRAMME COSTING

INCOME

College allocation 34,770,000/=

EXPENDITURE

I Teaching Expenses

Lecture/tutorials/practical hours @50,000 x 510 CH 25,500,000 /=

II Administrative Activities

College Activities (Administration/Cleaning, Furniture, etc.) 3,000,000/=

III Teaching Materials

Item	**Quantity**	**Amount**
Equipment and Computer Accessories	Item	3,000,000/=
Laboratory Costs	Item	2,000,000/=
Contingencies (Photocopying, Meetings, etc.)	Item	1,270,000/=