University of Nigeria, Nsukka

DEPARTMENT OF MECHANICAL ENGINEERING

POSTGRADUATE PROGRAMMES IN MECHANICAL ENGINEERING STUDIES

INTRODUCTION

The Mechanical Engineering's postgraduate programme brings together academics, professionals and students into a community of scholars who have a common interest in innovation,creativity and advanced professional study. In line with modern trends in curriculum development in Mechanical Engineering, the programme study includes basic courses necessary for every Mechanical Engineer, as well as courses for specialization in some areas of the discipline.

PHILOSOPHY

In keeping to the philosophy of University of Nigeria, the postgraduate programme of the Department of Mechanical Engineering is designed to make engineers that are innovative, creative and capable of advancing the engineering professional studies. At the end of the programme, the graduate will be able to understand and practice engineering beyond the knowledge acquired during the undergraduate studies. It is organized in five specialist areas namely: Energy and Power Technology, Materials Technology and Mechanics, Fluid Mechanics and Gas Dynamics, Design and Production Technology, and Industrial Engineering and Management. It seeks to provide great opportunity for advanced study and investigation through interactions among academics and professionals by sharing knowledge and research results. It is also designed to present an opportunity for personnel who had been out of the profession to connect back to it. Particularly, the postgraduate diploma in engineering is designed mainly for experienced engineers working in the Industry or Government, with the aim of advancing their knowledge in a specific area in addition to bridging a gap between undergraduate and advanced studies.

OBJECTIVES

The main objective of the programme is to produce graduates who can bring their academic and practical background to bear the problems of industries in Nigeria and beyond. Specifically, the programme is designed to achieve the following objectives:
- To produce qualified engineers in specialist areas
- To build capacity in advanced engineering science and industry capability
- To produce competent graduates proficient in research and development in mechanical engineering field

- To afford experienced engineers the opportunity to extend the boundaries of their profession.
- To prepare the students to be able to assume technical and academic leadership in the engineering world.

ADMISSION REQUIREMENTS

a. PGD. Eng. (Postgraduate diploma in Engineering) programme
It is available to holders of a first degree (B.Sc.) in a Physical Science discipline with a minimum GPA of 2.50 who wish to convert to engineering. It is also available to holders of Bachelor of Engineering (B.Eng.) with third class degrees who scored a minimum GPA of 2.00 and wish to improve themselves.

b. M.Eng. (Master of Engineering) programme
Candidates with B.Sc. (Engineering), B.Eng and candidates with appropriate Postgraduate Diploma in Engineering (PGD.Eng.) of the University of Nigeria or of other recognized universities with at least a GPA of 2.5 are eligible for admission to M.Eng. programme provided they satisfy the university's requirements for admission to Master's programme. Only students who scored a minimum GPA of 2.50 in their previous programme may be admitted to this programme.

c. Ph.D (Doctor of Philosophy) programme
Candidates who have successfully completed their Master's programmes (course work requirements and dissertation) in Mechanical Engineering may apply for admission into the PhD Programme. A candidate who has completed the course work requirements for a Master's in Mechanical Engineering, but who has not completed the thesis requirement, may also apply for admission to the PhD programme. Only students who scored a minimum GPA of 3.50 in their Master's programmes may be admitted to the PhD programme.

AREAS OF SPECIALIZATION: M.Eng. & Ph.D
 Energy and Power Technology,

    i)   Materials Technology and Mechanics,
    ii)   Fluid Mechanics and Gas Dynamics,
    iii)   Design and Production Technology,
    iv)   Industrial Engineering Management

DURATION OF PROGRAMMES
  PGD
 a) Candidate with B.Sc. in Physical Sciences background
      i. Full-time: Minimum of four (4) semesters.
      ii. Part-time: Minimum of six (6) semesters.

b) Candidate with B.Eng. background

      i.   Full-time: Minimum of two (2) semesters.

      ii. Part-time: Minimum of four (4) semesters.

M.Eng.

      i.   Full-time: Minimum of four (4) semesters.

      ii. Part-time: Minimum of six (6) semesters.

Ph.D

      i.   Full-time: Minimum of six (6) semesters.

      ii.   Part-time: Minimum of eight (8) semesters

SCOPE

The programme covers course work and research work. A project report or a thesis is required depending on the level of the programme.

Requirement for graduation

PGD

A candidate with B.Sc. in Physical Sciences background is required to take and pass a minimum of 67 credit units which include a supervised project report in any area of Mechanical Engineering.

A candidate with B.Eng. background is required to take and pass a minimum of 37 credit units which also include a supervised project report. The project report can be in any area of Mechanical Engineering.

M.Eng.

To be awarded M.Eng degree a student must have taken and passed the prescribed number of compulsory and required courses selected from the approved list, a total minimum of 33 credit units as follows

Taught courses	21 units
Research	6 units
Seminars	3 units
Project/dissertation courses	3 units

The 21 credits of course work will consist of 9 units of compulsory courses and 12 units of core courses selected from other areas of concentration. However the total courses selected must be such as to emphasize a particular area of specialization. There shall be a total of two

seminars for the Master's programme namely: the proposal, and the research findings seminar.

Ph.D

To be awarded Ph.D degree a student must have taken and passed total of 33 credit units as follows

Research/thesis	12 credit units,
Seminar presentations	6 credit units,
Thesis courses	3 credit units
Taught courses	12 credit units

The seminar presentations consist of 2 presentations and will cover the proposal seminar, work in progress seminar and research findings seminar.

The Ph.D. thesis must be defended before an external examiner dully nominated for that purpose and appointed by Senate

At the start of the Ph.D programme, the department will select a thesis supervisor who will discuss and agree upon a thesis topic with the candidate. The department will also select a thesis committee of not less than three members. At least one of the committee members must be from outside the research group with which the candidate is associated. Qualified people from the Industry may be invited to serve as additional members of the committee. The Ph.D thesis will normally consist of a theoretical and an experimental investigation. It must be original and creative, and will generally result in the development of a new technique, process or correlation, as well as in the advancement of knowledge beyond the current frontier. Within the first year of the programme, a qualifying exam will be administered. The qualifying exam will consist of written and oral parts in three subjects at postgraduate level selected by the candidate from the core area. The student must make a minimum average of 60% in the qualifying exam to be able to continue with the Ph.D programme.

Note: The award of postgraduate degrees will be based on the satisfaction of the requirements as stipulated in the Postgraduate Studies Regulations. The passing grade for postgraduate courses is "C" or 50% and minimum CGPA must be obtained before a degree is awarded.

LIST OF APPROVED SUPERVISORS

PROFESSORS:

O.V. Ekechukwu,   Solar Energy
B.Sc. (Ibadan), Ph.D (Cranfield)

S. O. Enibe,   Energy & Power Technology
B.Sc. (Nig), M.Sc. (Reading), Ph.D (Nig.)

S. O. Edelugo,   Design & Production
B.Eng. (Asutech), M.Eng, (ESUT), Ph.D (Nig.).

G. O. Unachukwu   Energy & Power Technology
B.Sc. (Nig.), M.Eng, (UniPort), Ph.D (Nig.)

SENIOR LECTURERS:

S. C. Nwanya,
B.Eng. (FUTO), M.Eng (Nig.) Ph.D (Udinese)   *Industrial Engineering & Mgt*
J. I. Ume,   *Process Design & Optimization*
B.Sc. (Lagos), M.Sc. (Lagos), Ph.D (Penn. State)

S. A. Ugwu
B.Eng. (Nig), M.Sc. (ABU)

C. A. Mgbemene,   *Energy & Power Technology*
B.Eng. (Nig.), M.Eng. (Nig.), Ph.D (Nig.)

H. O. Njoku,   *Energy & Power Technology*
B.Eng. (Nig.), M.Eng. (Nig.), Ph.D (Nig.)

E. C. Okoroigwe   *Energy & Power Technology*
B.Eng. (FUTO), M.Eng (Nig.) Ph.D (Nig.)

LECTURERS I:

M. N. Eke, *B. Eng. (FUTO), M.Eng. (Nig.), Ph.D (Nig.)*

P. A. Ozor   *Industrial Engineering & Management*
  B. Eng. (ESUT), M.Eng. (Nig.), Ph.D (Nig.)

C. G. Ozoegwu   *Design & Production* *B. Eng. (Nig), M.Eng. (Awka), Ph.D (Awka.)*

C. O Agbo   *Design & Production*
  B. Eng. (Nig), M.Eng. (Nig), Ph.D (Nig)

COURSE OUTLINE

COURSES FOR POSTGRADUATE DIPLOMA CANDIDATES

The Postgraduate Diploma programme of the department has duration of a minimum of four (4) semesters for students with B.Sc. in Physical Sciences background and a minimum of two (2) semesters for students with B.Eng. background. The latter are not expected to take the first year courses listed below.

First year

A. First Semester Courses for PGD with B.Sc. in Physical Sciences background

Course No.	Title	Units
ENGR 0601	Computational Methods	3
MEC 0614	Mechanical Engineering Design I	3
MEC 0641	Mechanics of Machines I	2
MEC 0642	Automatic Control	3
MEC 0661	Thermodynamics II	2
MEC 0691	Metallurgy	2

B. Second Semester Courses for PGD with B.Sc. in Physical Sciences background

Course No.	Title	Units
MEC 0616	Manufacturing Technology	2
MEC 0617	Engineering Drawing II	2
MEC 0619	Mechanical Engineering Laboratory	3
MEC 0631	Advanced Strength of Materials	3
MEC 0643	Measurement and Instrumentation	2
MEC 0651	Mechanics of Fluids I	3

Second year (for PGD with B.Sc. in Physical Sciences background, but first year for PGD with B.Eng. background)

A. First Semester Courses.

Course No.	Title	Units
MEC 0618	Mechanical Engineering Design II	3
MEC 0632	Theory of Elasticity	3
MEC 0644	Mechanics of Machines II	2
MEC 0652	Applied Fluid Mechanics	2
MEC 0662	Applied Thermodynamics	2
MEC 0663	Thermodynamics III	3
MEC 0671	Heat and Mass Transfer	3
MEC 0681	Engineering Law & Management	3

B. Second Semester Courses.

Course No.	Title	Units
MEC 0692	Engineering Metallurgy	3
MEC 0600	Project Report	4
(Plus 3 elective courses, one from each of the underlisted option areas)		9

Option areas

A. Heat Power/Thermal Engineering Option:

Course No.	Title	Units
MEC 0664	Fundamentals of Nuclear Engineering	3
MEC 0668	Power-plant Engineering	3
MEC 0669	Energy Conversion Principles	3
MEC 0672	Thermal Engineering and Advanced Heat Transfer	3
MEC 0673	Refrigeration and Air-Conditioning	3

B. Design and Manufacturing Engineering Option:

Course No.	Title	Units
MEC 0612	Manufacturing and Tools Engineering	3
MEC 0613	Design of Welded and Cast Structures	3
MEC 0633	Theory of Elasticity II	3
MEC 0645	Vibrations and Control	3
MEC 0646	Systems Engineering	3
MEC 0647	Fluid Power Control Engineering	3
MEC 0649	Instrumentation and Control Engineering	3

Option areas (for PGD with B.Eng. background)

Choose any three courses from section 2.3 (OPTIONAL COURSES) but not more than two from any of the areas of specialization (A to E).

M.Eng.

Course No.	Title	Units
MEC 690	M.Eng. Project Report	6

First semester compulsory courses (compulsory for M.Eng. candidates)

Course No.	Title	Units
MEC 601	Advanced Thermodynamics I	3
MEC 663	Engineering Design and Systems Analysis	3
MEC 699	Analytical Methods in Engineering	3
MEC 691	Seminars	3
PGC 601	Research Methodology and ICT in Engineering	3

Second semester courses(optional courses for M.Eng. candidates)
(Options must emphasize student's area of specialization.)

All candidates must register 4 (four) courses from the course listing of their area of specialization during the second semester. In addition, they must select the course listed in section 2.4 if it is appropriate to their level. Optional courses are to be registered,however, with regards to the availability of lecturers teaching them in any academic year. The advice of the postgraduate coordinator should be sought where taught courses in an area are not up to 4 for any academic year.

OPTIONAL COURSES

A. ENERGY AND POWER TECHNOLOGY

Course No.	Title	Units
MEC 602	Advanced Thermodynamics II	3
MEC 603	Advanced Air-Conditioning and Refrigeration	3
MEC 604	Cryogenics and Gas Liquefaction	3
MEC 605	Direct Energy Conversion	3
MEC 606	Solar Energy Conversion	3
MEC 607	Energy Management	3
MEC 608	Advanced Heat & Mass Transfer	3
MEC 609	Two Phase Flows & Heat Transfer	3
MEC 610	Conduction	3
MEC 611	Turbomachinery	3
MEC 612	Turbine Plant Performance (Gas and Steam Turbines)	3

| MEC 613 | Propulsion | 3 |
| MEC 614 | Reactor Design and Control | 3 |

B. MATERIALS TECHNOLOGY AND MECHANCIS

Course No.	Title	Units
MEC 620	Advanced Mechanics of Materials	3
MEC 621	Mechanical Properties of Metals and Alloys	3
MEC 622	Process and Extraction Metallurgy	3
MEC 623	Physical Metallurgy	3
MEC 624	Industrial Metallurgy & Fabrication	3
MEC 625	General Dynamics	3
MEC 626	Advanced Vibrations	3

C. FLUID MECHANICS AND GAS DYNAMICS

Course No.	Title	Units
MEC 640	Advanced Fluid Mechanics	3
MEC 611	Turbomachinery	3
MEC 641	Boundary Layer Theory	3
MEC 642	Low Speed Flow	3
MEC 643	One Dimensional Gas Dynamics	3
MEC 644	Multi-Dimensional Gas Dynamics	3

D. DESIGN AND PRODUCTION TECHNOLOGY

Course No.	Title	Units
MEC 660	Production Technology	3
MEC 661	Machine Tool Engineering	3
MEC 662	Analysis of Manufacturing Processes and Machines	3
MEC 664	Design of Control System Components	3
MEC 665	Dynamic Problems in Design	3

E. INDUSTRIAL ENGINEERING AND MANAGEMENT

Course No.	Title	Units
MEC 681	Organization & Management of Human Resources	3
MEC 682	Operations Research Models in Industrial Engineering	3
MEC 683	Inspection, Quality Control & Reliability	3
MEC 684	Industrial Production Systems Design	3
MEC 685	Analysis of Capital Investment	3
MEC 686	Engineering Organization and Management	3

SERVICE COURSE

Course No.	Title	Units
MEC 670	Process Engineering for Brewers	6

Ph.D

Course No.	Title	Units
MEC 790	Ph.D Thesis	12

First semester courses (compulsory for PhD candidates)

Course No.	Title	Units
MEC 701	Boundary Value Theories	3
MEC 703	Applied Numerical Methods and Continuum Mechanics	3
MEC 791	Seminar I	3
MEC 792	Seminar II	3
PGC 701	Synopsis and Research Grant Writing	3

Second semester courses

(Compulsory for Ph.D candidates)

MEC 722	Linear Statistical Models and Multivariate Analysis	3

(Optional for Ph.D candidates)

MEC 706	Essentials of Computer Aided Design/Engineering/ Manufacture	3
MEC 746	Simulation	3
MEC 748	Any postgraduate level course as recommended by the supervisor provided the student is qualified to take that course.	3

Note:

All Ph.D candidates must register MEC 701, MEC 703, MEC 722, MEC 791, MEC 792 and PGC 701 as the core courses and then select MEC 706 or MEC 746 or MEC 748 as the optional course to complete the required total for course work of 21 credit units. Apart from the above listed Ph.D courses, all candidates who did not obtain their M.Eng. degrees in this Department must pass MEC 699 in addition to any of the following courses to emphasize their research area:

MEC 608 - Candidates in Energy and Power Technology
MEC 620 - Candidates in Material Technology and Mechanics
MEC 665 - Candidates in Design and Production Technology
MEC 682 - Candidates in Industrial Engineering and Management
MEC 640 – Candidates in Fluid Mechanics and Gas Dynamics

COURSE DESCRIPTION

POSTGRADUATE DIPLOMA (PGD.Eng) COURSES

ENGR 0601 – Computational Methods
Polynomials and their zeros – Methods of bisection, Newton, Bairstow, Synthetic division and Lehmer; Direct methods for the solution of Linear equations. Iterative process, its application to the solution of simultaneous linear equations; Convergence; Interpolation and differentiation method in Numerical Integration – Newton Coates formulae and finite difference methods; The eigenvalue problem solution of ordinary differential equations – methods of Taylor, Euler, Predictor – Corrector and Runge-Kutta.   (3 units)

MEC 0612 – Manufacturing and Tools Engineering
Manufacturing unit processes and material considerations. Casting techniques. Solidification and heat flow theory, defect formation, casting design, metal forming, elementary plasticity theory, plastic failure criteria, force and work calculations. Power forming techniques; theory and practices of power consolidation, design considerations. Joining techniques; heat flow and defect formation theory, residual stresses. Machining theory and practice. Heat treatment and surface hardening. Diffusion theory, principles of wear resistance. Metrology. Tools engineering: tool materials, plastic mould design, jig and fixture design principles, die design, mechanized assembly, and functional ganging. Fundamental aspects of machine tool design and control, machine tool dynamics and computer aided design.   (3 units)

MEC 0613 – Design of Welded and Cast Structures
Review of elastic, plastic, and creep behavior of materials and introduction of low-cycle and multi axial stress fatigue. Welding and casting processes. Design of weldments and castings with application to pressure vessels and other structures. Analysis of industrial welding processes. Material and process selection, codes and specifications, costing equipment. Laboratory experience in the production and evaluation of weldments and castings.   (3 units)

MEC 0614 – Machine DesignI
Principles of Design. Selection of Materials. Design and composition of cast, forged and welding housings and structures; design or plastic parts. Precautions for manufacture. Simple stress analysis. Use of threaded and non-threaded fasteners. Elastic deformation of machine parts. Design of screws. Strength under combined load. Shaft design. Flexible mechanical elements. Couplings, clutches and brakes. Mechanical springs, Anti-frication bearing – rolling contact bearings.   (3 units)

MEC 0616 – Manufacturing Technology
History of machining machine tools. Lathes, drill press, millers and grinders. Turning and boring operations, drilling milling, planning, shaping and grinding processes. Slotting and broaching, honing and lapping, gear cutting. Determination of spindle speeds and feed speeds. Machine tool installation, testing and maintenance.   (2 units)

MEC 0617 – Engineering Drawing II
Projection of lines and laminae; auxiliary views and mixed projection. Preparation of detailed working drawings for production; preparation of detailed working drawings for production; semi-detailed drawings, conventional presentation methods. Assembly drawing of machines, devices and installation layout; itemization and part listing. Drawing Office Practice and reprographics. Computer aided drawing (CAD).   (2 Units)

MEC 0618 – Machine Design II
Journal bearings. Application of Hertz stress theory. Gears, Power transmission systems. Elements of fluid power system design. Design of cylinders, pipes and pipe joints, tubes, plates and flywheel. Seals, packaging, gaskets and shields.   (3 units)

MEC 0619 – Mechanical Engineering Laboratory II
Heat Engine Tests, throttling calorimeter and Marcet boiler experiments. Fluid flow measurements. The slider crank experiment. Four bar mechanism. Hooks joints, Disc and cam follower experiment. Whitworth quick return mechanism, slotted link. Scotch yoke, Geneva stop and Oldham coupling.   (3 units)

MEC 0631 – Advanced Strength of Materials
Two-dimensional stress and strain analysis. The concept of stress at a point, principal stresses, principal strains; Hooke's law; torsional loading; shear forces and bending moments; thick and thin-walled cylindrical pressure vessels; deflection under flexural loading, statically determinate and indeterminate structures, shear flow, strain energy, failure theories; repeated loading, impact loading.   (3 units)

MEC 0632 – Theory of Elasticity I
Strain energy, principle of virtual work, Castigliano's theorem, principle of least work; statically indeterminate beams; plastic analysis; columns – stability of elastic mechanical systems, long straight columns effect of and conditions; the secant formula, empirical formulae for intermediate and short columns, eccentric loading; repeated loading; impact loading.

(3 units)

MEC 0633 – Theory of Elasticity II
Anti-elastic bending. Theory of plates and shells. Thermal stresses. Stresses in rotating discs. Theory of elasticity. Equilibrium and compatibility equations. Airys stress function with applications to simple problems. Crack mechanics, stress-function, approach to fracture mechanics. Direct stiffness method, the finite element method for stress analysis. Plastic theory.

(3 units)

MEC 0641 – Mechanics of Machines I
Kinematics of mechanisms. Loci, graphical analysis, instant centres, images. Flexible shaft couplings, virtual work, energy and speed fluctuations in machines. The fly-wheel and mechanical governors. Acceleration of geared system, equilibrium of machines, brakes and dynamometers. Acceleration of geared system, equilibrium of machines, brakes and dynamometers. Acceleration and braking of vehicles. (2 units)

MEC 0642 – Automatic Control
Linear feedback control theory with emphasis on mechanical systems; transient and frequency response; stability; system performance, control modes; compensation methods; analysis of hydraulic pneumatic, inertial components and systems. (3 units)

MEC 0643 – Measurement and Instrumentation
Measurement principles and basic definitions. Standards. Accuracy and error analysis; measurement statistics; instrument systems; sensing devices, transmitting devices, terminating devices; typical systems and devices for measuring quantities such as temperature, pressure, flow, size, displacement, velocity, acceleration, force, power, torque, stress and strain. Analogue methods of measurement. Dynamics of measurement. Data presentation and curve fitting.

(2 units)

MEC 0644 – Mechanics of Machines II
Gear tooth geometry, involumetry. Spiral gearing. Cams, displacement diagrams, layout, equivalent mechanisms. Force analysis of mechanisms, fluctuation of kinetic energy and inertial effects. Complete static and dynamic analysis. Balancing of multi-cylinder engines.

(2 units)

MEC 0645 – Vibrations and Control
Free and forced oscillations of single degree of freedom systems. Damped vibrations. Vibration isolation and measurement. Two and multiple-degrees of freedom systems. Electro-mechanical analogies. Linear systems of the first order. Response to standard inputs. The closed loop control system. Block diagram algebra. Stability analysis. Electrical systems. Dynamics of Machinery: Kinematic and dynamic analysis and synthesis of mechanisms and machines, design and analysis considerations in reciprocating and rotating machinery, vibrations in machinery, vibrations of

systems with more than one degree of freedom. Vibration and shock isolations. Experimental investigation of dynamic systems. (3 units)

MEC 0646 – Systems Engineering

System modeling: Modeling of systems by algebraic, difference, ordinary differential equations, and partial differential equations. System simulation using analogue, hybrid and digital computers. System optimization using differential calculus, variational calculus, linear programming and dynamic programming. System behavior: categories of systems, behavior illustrated by the study of selected mechanical, electrical, hydraulic, industrial, transportation, economic, biological and social systems. System control. Decision analysis. Estimation of input values. Utility and value analysis. Multiple objectives and criteria. Production functions and marginal analysis. Econometrics. Evaluation of a public system. (3 units)

MEC 0647 – Fluid Power Control Engineering

Properties of hydraulic fluids; dynamic flow analysis; Hydraulic, pneumatic, and fluids systems and components; characteristic of flow and pressure control valves, actuators, position motors, pumps; Hydro-static and hydrodynamic power transmission systems. Filtration and heat control in hydraulic systems. Seals and packings. System design and circuit analysis. Introduction to pneumatics Pneumatic logic control. Applications and testing procedures. (3 units)

MEC 0649 - Instrumentation and Control Engineering

Measurement principles and basic definitions. Standards. Accuracy and error analysis; measurement statistics. Instrument systems; sensing devices, transmitting devices, terminating devices. Typical systems and devices for measuring quantities such as temperature, pressure, flow, size, displacement, velocity, acceleration, force, power, torque, stress and strain. Analogue methods of measurement. Dynamics of measurement. Data presentation and curve fittings. Laboratory work in measurement techniques. Control Engineering: Mechanical, pneumatic, hydraulic and hybrid fed back control systems, analysis, using Laplace transforms and state-space. Laboratory exercises include setting up and analyzing pneumatic, fluidic, and hydraulic control systems. Use of analogue computers. (3 units)

MEC 0651 – Mechanics of Fluids I

Kinematics of fluid motion; streamlines, velocity, acceleration, rotation and circulation. Control volume analysis; continuity, momentum, angular momentum and energy equations. The Euler and Bernolli equations. Differential analysis; Laminar incompressible flow between parallel plates, circular tubes and circular annuli. Laminar and turbulent flow in pipes. Fluid measurements; pressure velocity and flow rates. (2 units)

MEC 0652 – Applied Fluid Mechanics

Dimensional analysis and similitude. Introduction to Turbo machinery; characteristic curve for axial-flow and centrifugal pumps, fans, blowers, impulse and reaction turbines, fluid couplings, Lubrication mechanics; Hydrodynamic theory applied to tapered wedge and journal bearings, hydrostatic lubrication applied to journal bearings. (2 units)

MEC 0661 – Thermodynamics II

Thermodynamic properties, energy relations and conservation. Paths and processes. Cycle analysis, reversibility. The first law and second law of thermodynamics, entropy. Irreversibility and availability. Air-standard cycles. Power and efficiencies. (2 units)

MEC 0662 - Applied Thermodynamics

Multistage reciprocating compressors: the rotary compressors – centrifugal and axial-flow; stagnation properties. Simple gas turbine plant; the steam power plant. Combustion of fuels; chemistry of common hydrocarbon fuels, combustion with deficiency or excess air. Thermo-chemistry; Hess' Law of Heat Summation; Heats of combustion and reaction; Ideal adiabatic flame temperature; Reciprocating internal combustion engines. (2 units)

MEC 0663 – Thermodynamics III

Non-ideal pure substances. Equations of state and compressibility factors. General thermodynamic relations Maxwell's relations, T-ds equations, energy equations Claudius Claperon equation difference in heat capacities, Joule Thomp son's coefficient. Mixtures and solutions; Fugacity and activity coefficients. Thermodynamics of chemical reactions first llaw and second law analyses or reacting systems. Dissociation and equilibrium constants. Introduction to phase and chemical equilibrium. (3 units)

MEC 0664 – Fundamental of Nuclear Engineering

Introduction of nuclear reactor engineering: radiation protection and reactor safe-guards, radiation hazards and health physics, reactor shielding principles and geometric transformation, shield design, nuclear reactions and radiations. Neutron balance. Neutrons reactor theory, homogenous and heterogeneous reactor system. Water moderated and fast reactors. Control of nuclear reactors. Thermal problems in reactor coolants, reactor structural and moderator materials. Reactor fuels: production properties, reprocessing and waste disposal. Nuclear reactor system Application of nuclear techniques in industries. (3 units)

MEC 0668 – Power Plant Engineering

Introduction to Power Plants: energy sources, availability, resources; fundamental combustion processes of solid. Liquid and gaseous fuels. Steam power plants: steam generators, burner designs, auxiliary power station equipment. Diesel and gas turbine plants; Hydroelectric power plants: dams and plant auxiliaries; Nuclear power plants: fuels and nuclear fission, reactor types, nuclear waste; Geothermal power plants; design and operation of equipment; Alternative energy

forms: solar, wind, tides, geothermal, hydrogen and biomass; performance and selection of prime movers for small power generating plants; Fundamentals of electrical generators performance and energy distribution systems. (3 units)

MEC 0669 – Energy Conversion Principles

Thermodynamic principles of energy conversion systems: Emphasis on direct energy conversions including thermoelectric, photovoltaic, thermionic, magnetohydrodynamic. And electro-gas dynamic devices; fuel cells, solar energy and nuclear power sources. Alternate energy sources. Solar, wind, tides, geothermal, hydrogen, biomass and biomass conversion, battery technology. (3 units)

MEC 0671 – Heat and Mass Transfer

Modes of heat transfer. General heat conduction equation. Steady state conduction in one dimension, composite bodies, lagging, and economics of insulation. Thermal convection: Use of dimensional analysis. Radiative heat transfer: Black bodies, grey surfaces. Heat exchangers, extended surfaces, engine cooling. Combined modes of heat transfer. Mass transfer between phases, humidification of gases, types of dryers, evaporation. (3 units)

MEC 0672 – Thermal Engineering and Advanced Heat Transfer

Advanced heat transfer: unsteady conduction, analytical methods, graphical and numerical methods, electrical analogue circuits. Energy transfer with change of phase, iterative processes in combined modes. Solar Energy: nature of solar radiation, direct, diffuse and reflected irradiance, ephemeris transit, equation of time. Solar flux, solar collectors, applications of solar energy and prospects. Refrigeration and air-conditioning 'air refrigerating cycles, common refrigerants, complex vapour-compression systems, binary systems. (3 units)

MEC 0673 – Refrigeration & Air-Conditioning

Fundamentals of vapour compression refrigeration, analysis of refrigeration cycles and equipment. Refrigerants and their properties. Absorption refrigeration systems. Low temperature refrigeration. Refrigeration Applications, Elements and Design of Refrigeration systems. Reverse application of refrigeration – heat pumps. Steady state and transient cooling load calculations. Principles of air-conditioning with emphasis on thermodynamic processes involving air, water, vapour mixtures. Production of atmospheric and thermal environments for human activity. Heat sources and climatic considerations. Comfort and physiological aspects. psychrometry and psychrometric processes. Evaluation of cooling and heating loads. Methods of reducing cooling loads. Air-conditioning systems and equipment. Ducts and fans. Chilled water and condenser water piping. Steam piping and heating systems. Air-conditioning controls. Ventilation and air-conditioning systems. (3 units)

MEC 0681 – Engineering Law & Management
LAW: GENERAL PRINCIPLES OF CONTRACTS
Law of Contract: Forms of contact criteria for selecting contractors offer and acceptance of contracts: Terms of Contracts Suppliers Duties – Damages and other Remedies. Termination/Cancellation of Contract Liquidation and Penalties, Exemption clauses, safety and Risk. Health and Safety. Duties and Employers towards their employees. Duties imposed on employees. Fire precautions act. Design for safety.
MANAGEMENT: General principles of management and appraisal techniques. Break through and control management theory; personnel management, labour and public relations, wages and salary administration. Production and maintenance management. Training and manpower development. The manager and policy formulation, objective setting, planning, organizing and controlling, motivation and appraisal of results.   (3 Units)

MEC 0691 – Metallurgy
The modification of properties through changes in microstructure. Welding Metallurgy; modern techniques of welding and applications. Weldability of industrial materials. Destructive and non-destructive testing of materials, ultrasonic and X-ray tests. Analytical principles. Metallic and non-metallic compounds is metals.   (2 units)

MEC 0692 – Engineering Metallurgy
Age-hardening and isothermal transformation processes, quenching and tempering, hardenability and graphitization processes. Fracture mechanics applied to metal, ceramics and polymers. Dislocation. X-ray and electron diffraction. Industrial metallurgy, corrosion and high temperature oxidation theories. Material conservation. Quenching of metals, glasses, polymers textiles, paper and wood. Transport processes; analysis of heat and mass in materials processing operations.   (3 units)

MEC 0600 – Project Report
Each student is expected to write a supervised project report in any area of Mechanical Engineering. The report must demonstrate that he/she has acquired relevant and standard skills in scientific investigation and also contribute to knowledge.   (4 units)

3.2 MASTER OF ENGINEERING (M.Eng) COURSES

MEC 601 Advanced Thermodynamics I
Equilibrium. First law. Second law. State principle, Zeroth law. Criteria for equilibrium. Temperature, Entropy and Exergy Analysis, Exergetic (Second law) efficiency, Chemical Exergy. Maxwell Relations. Open systems. Phase rule. Systems of one and two components. Idealized and real gases, mixtures, and solutions. Equations of state. Thermodynamic potentials.

Heats of formation. Chemical Reactions. Chemical equilibrium and combustion in complex reacting systems. Frozen states in gas dissociation. Real gas dynamic applications. Emission of pollutants.   (3 units)

MEC 602 Advanced Thermodynamics II
Statistical thermodynamics: Systems and ensembles. Third law. Kinetic theory. Maxwell's transfer equation. Thermodynamics equilibrium and viscous, heat conducting gases. Boltzmann statistics, quantum statistics. Dilute gas properties.   (3 units)

MEC 603 Advanced Air Conditioning and Refrigeration
Psychiometry and its application to design problems on comfort air conditioning and to problems involving heat and mass transfer in spray equipment. Cooling load estimates. Accommodation of solar gains to buildings. Extended surface coils for cooling and dehumidification. Typical air conditioning equipment and control systems will be considered in relation to specific problems, including solar dryers, heaters, and coolers Project. (3 units)

MEC 604 Cryogenics and Gas Liquefaction (Low Temperature Refrigeration)
Thermodynamic processes for producing low-temperature refrigeration. Problems of heat exchangers, insulation and rectification. Application of oxygen and nitrogen. Liquefaction of Natural Gas. Transport and Storage of cryogenic fluids. Low temperature thermometry. Properties of cryogenic fluids. Properties of Materials at low temperatures. Laboratory projects on related topics.   (3 units)

MEC 605 Direct Energy Conversion
Introduction to semiconductors. Basic ideas of quantum physics, energy bands, intrinsic and extrinsic semiconductors. The Hall effect, thermoelectric effects and optical effects. Analysis and design of thermoelectric devices (generators and coolers), thermionic converters, fuel cells, photovoltaic generators, and magnetohydrodynamic (MHD) power system.   (3 units)

MEC 606 Solar Energy Conversion
Review of Heat Transfer. Fundamentals of Solar Energy: extraterrestrial irradiance and atmospheric extinction. Insolation correlations, total transmittance into buildings and irradiance on inclined surfaces. Solar energy collection and storage; selective surfaces Eutectic salts. Direct use of Solar Energy: STEG and Solar cells. Solar Collectors, types, performance and ratings. Solar Refrigeration and Cooling of Buildings: active and passive coolers. Heating applications. The Solar powered organic vapour cycles. Open Air Space and the Legal implication of Solar Energy use in urban area.   (3 units)

MEC 607 Energy Management

Energy Resources. Energy use. Elements of Heat Transfer-Conduction, Convection and radiation. Sources of energy waste in Buildings and Industrial systems. Equipment efficiency. Measurement of energy loss. Energy conversion measures. Regeneration. Insulation. Used for waste heat and cold. Temperature control – the thermostat in heating and cooling applications. Power factor. Total Energy systems. Case study – The University of Nigeria. Energy policy. Class projects.   (3 units)

MEC 608 Advanced Heat and Mass Transfer

Review of Modes of Heat Transfer, and one-dimensional steady state conduction. Transient 1-D conduction. Internal Heat generation. Ablation. Review of Momentum transfer in Lamina and Turbulent Flows. Solutions for simple Geometries. Navier-Stokes Equations. Universal velocity Distribution and Empirical Correlations. Heat Transfer in Laminar Flow. Free and forced convection. Simple solutions and Correlations. Heat Transfer in Turbulent Flows. The Momentum-Heat Transfer Analogy. Analytical Solutions. Experimental Results for Forced and Free Convection. Thermal Radiation. Radiation Networks. Heat Transfer Correlations in Boiling and Condensation. Heat Exchangers, boilers, condensers, coolers. NTU and other Design Methods, Mass Transfer in Stationery, Lamina and Turbulent Flows, Numerical and Analog Methods in Steady and Unsteady problems.   (3 units)

MEC 609 Two Phase Flows and Heat Transfer

Definitions of Terminology. Flow regimes and Regimes Boundaries. Continuity, Momentum and Energy Equations in Two Phase Flows. Bubbly, slug, separated and Dispersed Flows. Counter-current flows and phenomena. Boiling. Nucleation. Effect of surface characteristics. Pool Boiling and the Boiling curve. Pool Boiling Correlations. Flow Boiling. Flow Regimes in Flow Boiling on a vertical Tube. Flow boiling Correlations. Flow Film Boiling. Rewet in Pool and Flow Boiling. Condensation-Dropwise and Film Condensation. Effect of surface conditions. Empirical Correlations in Condensation.   (3 units)

MEC 610 Conduction

Brief review of one-dimensional conduction. Lumped, Internal and Differential Formations. Steady-one dimensional problems. Principle of superposition. Heterogeneous solids. Power series solutions and Bessel functions. Steady 2 and 3 dimensional problem solutions by Laplace Transform. Variational Formations and Approximate Profile Techniques. Differences and Differential Formations and Solution Techniques.   (3 units)

MEC 611 Turbomachinery

General equations of flow (continuity, energy, momentum); definitions of efficiency, dimensional analysis. One-dimensional design of axial compressors and turbines; two-

dimensional potential flows. Three-dimensional flow; radial equilibrium equations; actuator-disc theory; miscellaneous topics; design example.   (3 units)

MEC 612 Turbine Plant Performance (Gas and Steam Turbines)
Gas Turbine Plant: plant components, Optimization of compression ratios, Regeneration, Reheat and Inter-cooling. Steam Plant: Plant components, Optimization of fed trams. Reheat cycles, Effect of increasing maximum pressures and temperature.   (3 units)

MEC 613 Propulsion
Thrust, Propulsive Efficiency, Thermal Efficiency and Overall efficiency of Air-breathing engines and rockets. Turboprops, turbofans, Turbojets and Ramjets: Cycle analysis including irreversibilities, Supersonic flight, and Shock losses.   (3 units)

MEC 614 Reactor Design and Control
The programmes would include reactor theory, reactor shielding, reactor materials, nuclear waste management, fuel reprocessing, reactor plant systems, and removal of hear energy from nuclear reactors. Thermal Hydraulics of Nuclear Reactors.   (3 units)

MEC 620 Advanced Mechanics of Materials
Theory of Stress, Yield Criteria. Theories of failure. Theory and measurement of strain. Matrix & Tensor notation. Stress-Strain-Temperature Relations for elastic solid. Strain Energy, St. Venant's Principle. Superposition. Energy Theorems. Stress Functions for two-dimensional problems, torsion problems, and axially symmetric problems. Approximate Methods. Plasticity. Deformation, Theory of rigid/plastic materials, and application. Theormoelasticity. (3 units)

MEC 621 Mechanical Properties of Metals and Alloys
A review of the Phenomenology and mechanisms of creep, fatigue and fracture in pure metals and alloys. Discussion of the basic theory dealing with the nature, generation, Kinetics and properties of dislocations in metals and their interactions with precipitates in alloys including the theory of diffusion. A detailed examination of the yield point phenomenon in pure metals and alloys including work-hardening processes.   (3 units)

MEC 622 Process and Extraction Metallurgy
(Physical chemistry of Metallurgical Processes). Procedures of the various extraction processes are described. Oxidation and reduction processes, hydrometallurgical processes. Methods of steel-making and the principles of hydro-and electrometallurgy extraction processes.
                                                                                                (3 Units)

MEC 623 Physical Metallurgy

The course discusses a detailed study of precipitation from supersaturated soil solution. The directional solidification and solidification of eutectic structures, thermal stability and the mechanical enquiry of such structures. Transformations in steels: eutectoid, bainitic and martensitic transformations. The metallurgy of special alloy steels including stainless and maraging steels. (3 units)

MEC 624 Industrial Metallurgy and Fabrication

The concept of this course is to examine the basic and fundamental principles of Industrial fabrication processes such as forging, extrusion, rolling, wire and deep drawing, stretch forming, powder and welding metallurgy. The philosophy of non-destructive testing of materials and its application in engineering. (3 units)

MEC 625 General Dynamics

Review of rigid body dynamics, moments and products of inertia, the symmetrical top, the gyroscope and applications. Lagrangian mechanics, canonical transformations. Hamilton-Jacobi theory. Perturbation methods. Stability and resonance of dynamical systems. Applications to particle and rigid body space mechanics. (3 units)

MEC 626 Advanced Vibrations

Brief review of mechanical vibrations with one degree of freedom. Variational mechanics. Lagrange's equations, Hamilton's principle. Multi-degree of freedom systems; approximate methods of calculating principal frequencies. Holtzer's method; Self-excited Vibrations. Nonlinear vibrations. Vibrations of continuous elastic systems, bars, beams, shafts, plates.
(3 units)

MEC 640 Advanced Fluid Mechanics

Continuum model; macroscopic properties of fluids, Thermodynamic relationship. Basic equations, methods of describing fluid motion; continuity equation, forces, stress tensor, strain and rotation; strain tensor, stress-rate of strain relation; Navier-Strokes and Energy equations. Special Equations; Non-dimensional equations, viscous, compressible and incompressible flows, creeping flows, inviscid compressible and incompressible flows, boundary conditions; boundary layers and turbulence. SoMEC solutions of the equations. Inviscid, incompressible flow around a circular cylinder; steady viscous incompressible pipe flow. Oscillating flat plate in a viscous incompressible fluid. (3 units)

MEC 641 Boundary Layer Theory

Fluid motion with friction, outline of boundary layer theory, Navier-Stokes equations, some exact solutions. Laminar boundary layers: on a plate, exact solutions for 2-dimensional, axially symmetric, 3-dimensional incompressible boundary layers, unsteady layers, approximate solutions, boundary layer control, thermal layers, compressible boundary layers. Boundary layer transition: experimental results, stability of laminar flow, comparison between theory and

experiment. Turbulent boundary layer: Fundamental theoretical models, in pipes, skin-friction drag, rotating discs, roughness, positive and negative pressure gradients, free turbulent flows jets and wakes.   (3 units)

MEC 642 Low Speed Flow
Introduction, Language, Terminology and Basic Concepts. General Properties of Irrotational Flow, Two-Dimensional Irrotational Flow. Three-Dimensional Irrotational Flow. Rotational Flow. Perturbation Methods.   (3 units)

MEC 643 One-dimensional Gas Dynamics
SoMEC basic thermodynamic concepts and definitions. The compressible fluid. Basic concepts of Gas Dynamics – vorticity, the Bernoulli Equation, The Continuity Equation, Entropy, The Energy Equation, Steady Isentropic Flow of a perfect gas along a Streamline, The Stagnation Conditions, The Compressibility Effect, The Speed of Sound.   (3 units)

MEC 644 Multi-dimensional Gas Dynamics
Basic Equation of Multi-Dimensional inviscid Adiabatic Flow. Croclo Theorem, Croclo Number, Velocity Potential and Stream Function, Basic Equations, Methods of solving governing equations. Oblique shock waves. Exact solutions of the Basic Equations – Prandtl-Meyer solution, control flows with axial symmetry (Taylor-Maccoll Solution), Hodograph method. The method of characteristics; Small perturbation theory. Higher great approximations.
                                                                                          (3 units)

MEC 660 Production Technology
An analysis of the physical, chemical and mathematical principles underlying modern manufacturing processes and processing equipment and technology, and the economics of shaping and joining materials in the liquid, plastic and solid phases. Basic plasticity. Melting and casting of metals. Fusion and sintering of metals. Hot forming of metals, cold forming of metals, explosive and hydro forming. Plastics and their manufacture. Joining of metals – Metal cutting principles, cutting tool geometry and tool materials. Tool wear mechanisms. Milling and broaching, metal grinding principles. Economics of metal removal: electrochemical, electro-erosion and laser machining. Ultrasonic machining. Vibration characteristics of machining operations.   (3 units)

MEC 661 Machine Tool Engineering
History of machine tools, classification of conventional machine tools and machining techniques: introduction to precision engineering. Analysis of conventional machine tools-main structure, primary and auxiliary motions: geometric surface generation; power transmission and gear diagrams; machine tool kinematics-analysis of kinematic schemes and constraints;

development of a machine tool from determined principal design specifications; selection of max to min range of cutting speeds and feeds using geometric and/or Arithmetic series, Design of Gear boxes and power units, stepless drives; Design of spindles, spindle bearings, and clutches. Design of mechanisms for rectilinear motion, periodic (intermittent) motions, reversing devices. Design of Beds, columns, tables, cross rails, carriages and ways, Design of elements of machine tools control systems, Dynamic calculation and analysis in machine tool design. Methods of static and dynamic tests, machine tool building and rebuilding technology. Introduction to advanced machine tools.   (3 units)

MEC 662 Analysis of Manufacturing Processes and Machines
Classification of industrial manufacture, analysis of machinery requirement, the concept of design for manufacture; theory of power absorption at tool point, merchant's chip formation theory, built up edge phenomena and frictional behaviour on the rake face, chipless machining techniques; techniques; Abrasive machining and super finishing. High energy forming methods; Engineering metrology, statistical quality control; design of jigs, fixtures, press tools and dies. The concept of automation, selection of power medium and control techniques for automation, cam dependent mechanized systems, sequence controlled systems, camless automatics. In-process error sensing techniques and adaptive control, Processing of non-metals. Numerically controlled machines, economics of NC machines, NC machining centres. Programming techniques, Tooling, and auxiliary equipment for NC. Materials handling techniques for automated manufacture of multi component products, logic and sequencing, introduction to robotics. Trends in modern manufacturing techniques. Development of industrial manufacturing machinery and systems in the context of a developing country. Planning for manufacture. Philosophy for investment or industrial machines.   (3 units)

MEC 663 Engineering Design and Systems Analysis
Philosophy of Engineering Design: techniques of analysis, synthesis and evaluation; the creative process: Design in the Corporate Environment: engineering research, marketing, finance and other corporate functions, - and comprehensive design. Development Engineering; post-initial design development of new products, value engineering; development testing Vs experimental research; case studies. Integrated treatment of mathematical modeling and analysis of mechanical systems. Modeling linear and non-linear systems, and their performance under transient, periodic and random loads. Theory of design, material considerations, optimization techniques, similitude, stability, design of experiments and evaluation of results.   (3 units)

MEC 664 Design of Control System Components
Electronic components. General considerations in the characterization of system components. Steady-state analysis of systems containing strongly nonlinear components. Application of the above to the study of electronic systems. Laboratory consisting of construction, on the analog computer, of vibrators, modulators, other basic electronic devices. Hydraulic and pneumatic

components and systems. Reading of descriptive material concerning fluid power control. Techniques for the simulation of dynamic systems by digital computers. Project consisting of the development and use of digital computer simulation of a complex hydraulic power control system. Control theory reduced to engineering practice through the analysis and design of actual systems in the laboratory. Experiments with pneumatic and electro-mechanical logic circuitry, and with mechanical, hydraulic, and electro-mechanical servo system. Systems analysis and synthesis applied to a variety of positioning speed control, and regulating system. (3 units)

MEC 665 Dynamic Problems in Design
Analytical methods for solution of typical vibratory and balancing problems encountered in mechanical systems. Special emphasis on methods of suppression and control. Design and analysis of rotating machines. Some important mechanical problems found in turbines and other high-speed rotating machinery such as: steady stresses from centrifugal forces; vibration problems; and dynamic stability of high-speed rotors. Mathematical techniques readily adaptable to computer solution.   (3 units)

MEC 670 Process Engineering for Brewers
Kinetics of Enzymes.   Reactions. Rate theories, analysis of rate equations, mechanisms of reactions, first order reactions, chain reactions, rate constants and equilibrium. Thermodynamics of aqueous reactions: First and second laws of thermodynamics. Concepts of internal energy, enthalpy and entropy. Heat of reaction, exothermic processes endothermic processes. Concepts of Heat and Mass Transfer. Unit Operations in Brewing. Fermentations, Distillations etc. economy of chemical processes. Material cost estimation, process cost estimation, total cost, variable const and chemical process optimization. Design and control of fermentation equipment/processes. Materials for construction. Application of (1) and (2) to the design and control of fermentation/distillation processes. Instrumentation.   (3 units)

MEC 681 Organization & Management of Human Resources
Personnel system and industrial relations: the recruitment, selection, utilization and development of human resources, with special emphasis on union-management relations, staffing – manpower planning recruitment, testing, selection, placement, orientation, training, promotion, compensation and performance Evaluation – Wage and Salary administration, job evaluation, performance standards and appraisal, employee benefits. Seminar on Personnel and industrial relations: Analysis of problems and policies in personnel and industrial relations in these areas, personnel philosophy, ethics, role of personnel, department; breadth of personnel department's responsibilities, implementation of personnel programs, collective bargaining, and contribution of personnel department to the organization.   (3 units)

MEC 682 Operations Research Models in Industrial Engineering
Deterministic models of operations research; Linear Programming, Network models, critical path scheduling, integer programming, branch-and-bound techniques, and dynamic programming. Stochastic models of operations research: Queuing theory, inventory theory, Markov chains, and computer simulation.   (3 units)

MEC 683 Inspection, Quality Control and Reliability
Statistical aspects of quality control; sampling plans for acceptance inspection, and for the control of production processes, adaptive; quality control, design of quality control systems. Engineering reliability. Analysis of failure data, estimates of hazard rates and failure distributions for the reliability of components and/or systems, acceptance sampling plans for quality control.   (3 units)

ME684 Industrial Production Systems Design
Theory of Design: Logic underlying strategies for achieving various activities. Relationship of system definition, evaluation tools, modeling, and computational methods to strategies. Satisfying vs. optimizing goals in design. Searching for alternatives: Means-end analysis, Heuristic methods, and resource allocation. Complete design of an industrial engineering system in one or two technology settings, e.g. manufacturing, hospital, communications, environment, transportation etc. design, scheduling and control of production systems based on mathematical, computational and other modern mathematical techniques. Design and selection of production systems, creation of new facilities, and the determination of plant location and size, Methods of system modeling using Markov chains, illustrated with a wide range of applications with special emphasis on control systems. Use of the statistics obtained from the Markov formulation estimation methods, tests of hypothesis for fitting data, state reduction techniques, model validation and control, optimization with policy interaction and linear programming. Problems in factory planning, materials handling, production line techniques, automation, plant facilities.
                                                                    (3 units)

MEC 685 Analysis of Capital Investment
Decision and cost Analysis: economic analysis of capital investment decisions. Accounting system as a data source for such decisions. Decision analysis as an aid in processing data, for management decisions. Analytical methods for choosing between competitive engineering proposals; general decision models and decision strategies. Decisions under risk and uncertainty, replacement, inventory, budding and purchasing models.   (3 units)

MEC 691 Seminars
The student must present at least two separate seminars on the research proposal and research findings. The seminars must be PowerPoint presentations.   (3 units)

MEC 699 Analytical Methods in Engineering
Numerical Methods-Polynomial interpolation and approximation, numerical integration, roots of equations, simultaneous linear equations and matrix inversion, Eigenvalues, numerical solution of ordinary differential equations. Partial Differential Equations – Quasi linear first order partial differential equations, second orde4r partial differential equations – Diffusion, wave and Laplace-type partial differential equations, Fourier and related transform methods, heat transfer, mechanics and gas dynamics applications. Practical techniques for ordinary differential equations, Laplace transform applications, asymptotic expansions, regular and singular perturbation expansions, examples in heat transfer and fluid mechanics. Statistical methods.

(3 units)

MEC 690M.Eng. Project Report
The project report is considered to be the centerpiece of a student's graduate experience. A student must complete an acceptable M.Eng. project report under the supervision of an approved supervisor. The report must be an in-depth study of a chosen topic in the area of specialization. It must be an original work of research, design and development.   (6 units)

3.3 DOCTOR OF PHILOSOPHY (Ph.D) COURSES

MEC 701 Boundary Value Theories
Sobolev Spaces, Set-Valued Analysis, Nonsmooth Analysis, Nonlinear Operators, Elliptic Differential Equations, Locally Lipschitz Functionals, Constrained Locally Lipschitz Functionals, Perturbation of Locally Lipschitz Functionals, Local Linking and Extensions, Continuous Functionals, Multivalued Functionals, Nonlinear Boundary Conditions, Variational Methods, Method of Upper and Lower Solutions, Positive Solutions and Other Methods, Hamiltonian Inclusions, Problems at Resonance, Neumann Problems, problems with an Area-Type Term. Strongly Nonlinear Problems, Method of Upper and Lower Solutions , Multiplicity Results, Positive Solutions, Problems with Discontinuous Nonlinearities, Set Theory and Topology, Measure Theory, Functional Analysis, Nonlinear Analysis.   (3 units)

MEC 703 Applied Numerical Methods and Continuum Mechanics
Review of advanced techniques and computational software for the modeling, simulation and optimization of engineering systems, such as MATLAB, Engineering Equation Solver (EES), Mathematics, Maple, Spreadsheets, etc. Application of one or more of these software to the solution of common problems in engineering, such as systems of linear algebraic equations, interpolation and curve fitting, roots of equations, numerical integration, initial value problems, boundary value problems, eigenvalue problems, parametric analysis and optimization.

(3 units)

MEC 706 Essentials of Computer Aided Design/Engineering/Manufacture
Sketching techniques – 2D sketches, geometric constraints, dimensioning sketches. Shape design – creating sketch features, parametric parts, work features, swept shapes, chamfers and fillets,

holes, threads, patterning and mirroring and thin-walled parts. Assembly design – designing assemblies and using project files in assembly designs. Constraining components - placing components in an assembly, constraining components, part design in an assembly. Interacting with an assembly - identifying parts in an assembly, analysis and motion tools, presenting assembly. View creation – drawing creation environment, base and projected views, section views, detailed views, managing views. Dimensioning, Annotations and Tables – Automated dimensioning techniques, manual dimensioning techniques, annotating holes and threads, creating centerlines, symbols and leaders, revision tables and tags. Annotating assembly drawings – Assembly-centric Bill of Materials.   (3 units)

MEC 722 Linear Statistical Models and Multivariate Analysis
Multivariate normal distribution. Distribution of linear and quadratic forms. General linear hypothesis (full rank). Least square theory, test of hypothesis. Hotelling's T_2 and Wishart distribution. Applications in multivariate tests. Classification problems, component and factor analysis   (3 units)

MEC 746 Simulation
System modeling. Generation of random numbers and random variables from distributions. Design and analysis of simulation experiments. Applications.   (3 units)

MEC 791 Seminar I
The student must present at least two separate seminars on the research proposal and work in progress. The seminars must be PowerPoint presentations.   (3 units)

MEC 792 Seminar II
The student must present a seminar on showing the research findings. The seminar must be PowerPoint presentations.   (3 units)

MEC 790 PhD Thesis
The PhD thesis is a principal component of the doctoral program in Mechanical Engineering. It is a major, original work, carried out in the student's area of specialization, and must makes significant contributions to knowledge. This part serves as the major indicator of the candidate's abilities and demonstrates that the candidate has got full understanding of the subject matter. It must be done under the supervision of an approved senior academic and a select thesis committee of not less than three members.   (12 units)