MASTER OF ENGINEERING IN MECHANICAL ENGINEERING

INTRODUCTION

The Department of Mechanical Engineering offers courses leading to Bachelor of Engineering, Master of Philosophy (MPhil) and Doctor of Philosophy (PhD) in Mechanical Engineering. The department shares the view with others that there is a need to develop postgraduate training facilities in Mechanical Engineering to meet the manpower requirements of industries, government departments and academic institutions. This postgraduate course, that combines both formal lectures and self-motivated research, aims to meet the present need. The Department has a highly qualified and enthusiastic team of academics with proven track record of research performance. This would be an asset to efficiently offer the proposed course in a very professional way. The research programs of the Department are aligned with the PNGUoT Corporate Plan 2019-2023 and the PNG Vision 2050 in achieving their objectives towards nation building. The Department is committed to produce highly skilled and qualified manpower for the various sectors of PNG as well as of the Pacific Island countries. The Department is also in touch and collaboration with the industries through the "Departmental Industrial Advisory Committee" to enrich the curricula.

The Syllabus of the MEng (Mech) is revised and updated to meet the needs of the industry as well as to bring the standard to at par to the overseas universities. In order to facilitate greater participation of practising engineers in industries and government departments, the course has been structured to have built-inflexibility.

RATIONALE

Department of Mechanical Engineering, PNG University of Technology, currently, offers Master of Technology (MTech) in Mechanical Engineering. Master of Technology is a broader term that may include disciplines, such as sciences and information technology, etc. However, Mechanical Engineering wants to focus only on engineering disciplines. Moreover, the proposed MEng (Mech) is in uniformity with most of the overseas institutions' degree awarding systems. The proposed MEng

(Mech) shall be in line with the Bachelor degree that recently been renamed by the PNG University of Technology authority as BEng (Mech) from Bachelor of Engineering Mechanical Engineering. Additionally, the increased number of subjects and more closely monitored research in MEng (Mech) will also enable students to develop problem solving skills and will help them in communicating the research findings to the stakeholders. Once this proposed program is approved, it would replace the current MTech in Mechanical Engineering.

PROGRAM OUTCOME

On completion of the MEng (Mech) program, the students will be able to:

PO1	Use knowledge of mathematical and scientific modelling to critically analyse, develop, design, build and maintain mechanical engineering systems.
PO2	Develop the experimental methodologies.
PO3	Draw well informed conclusions through the application of research-based knowledge and methods such as design of experiments, results, analysis and data interpretation.
PO4	Effectively communicate scientific and engineering concepts in a multi-disciplinary and multi team environment.
PO5	Perform professionally and ethically, with an appreciation of the values of lifelong learning, appreciate the value of social well-being and environmental issues of all engineering activities.
PO6	Develop and apply leadership, entrepreneurial and negotiation skills to all engineering activities.

ENTRY REQUIREMENTS

i. Candidates with a bachelor degree in any engineering or equivalent from a recognised institution.
ii. Minimum weighted average of 65% marks in a Bachelor program or a GPA of 2.6 out of 4.
iii. No 'Fail' in any subject of the completed Bachelor program

SUMMARY OF THE PROPOSED COURSE

The proposed MEng (Mech) degree program is a two-year full-time normal mode program of study. It offers four (4) compulsory core subjects and four (4) elective subjects, each with four (4) hours of teaching per week. The student shall satisfactorily complete four (4) core subjects and four (4) elective subjects during the first year of the studies. The whole of second year shall be reserved for research work. At the end of semester 1 and semester 2 of second year, the student shall satisfactorily present the work in the form of seminar and a panel of academics shall evaluate the student's work. MEng (Mech) Thesis shall be evaluated by two external examiners.

PROGRAM SCHEDULE

YEAR 1	Contact Hours/week	Common Credit
SEMESTER 1		
Three (3) Core subjects each 4 hrs per week	*12 (12/0/0)	54
One (1) Elective Subject	4 (4/0/0)	18
SEMESTER 2		
One (1) Core Subject at 4 hrs per week	4 (4/0/0)	18
Three (3) Elective Subjects at 4 hrs per week	12 (12/0/0)	54
DISSERTATION	4 (0/0/4)	6
YEAR 2		
SEMESTER 1		
DISSERTATION	20 (0/0/20)	30
SEMESTER 2		
DISSERTATION	20 (0/0/20)	30

*Lecture / Tutorial / Project

SCHEDULE OF SUBJECTS

Name of Subjects	Semester
MM 501: Advanced Engineering Mathematics I (Core)	I
MM 502: Advance Engineering Mathematics II	II
MM 503: Numerical Methods (Core)	I
MM 504: Research Methodology & Computation (Core)	I
MM 505: Dissertation	I & II
ELECTIVE SUBJECTS [SUBJECT TO AVAILABILITY OF RESOURDESS]	
GROUP- A: ELECTIVE SUBJECTS	
MM 510: Advance Machine Design	I or II
MM 511: Materials Handling System	I or II
MM512: Computer Aided Design	I or II
MM513: Finite Element Method	I or II
MM514: Advanced Vibration	I or II
MM515: Noise Control Engineering	I or II
GROUP.B: ELECTIVE SUBJECTS	I or II
MM 520: Computer Integrated Manufacturing	I or II
MM 521: Conventional Manufacturing	I or II
MM 522: Robotics in Manufacturing	I or II
MM 523: Just-in-Time Systems	I or II
MM 524: Advanced Quality Control	I or II
MM 525: Planned Preventive Maintenance	I or II
GROUP.C: ELECTIVE SUBJECTS	

MM 530: Internal Combustion Engines	I or II
MM 531: Gas Turbines	I or II
MM 532: Hydraulic Machines	I or II
MM 533: Advanced Heat Transfer	I or II
MM 534: Renewable Energy	I or II
MM 535: Fossil Fuels & Combustion Technology	I or II
MM 536: Refrigeration & Air-Conditioning	I or II

DETAILED SYLLABUS

MM 501: ADVANCED ENGINEERING MATHEMATICS I

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes

On completion of the subject, the students should be able to:

1. Master first, second and higher order differential equations and systems of ODE
2. Acquire advanced knowledge regarding series solutions of ODE: Legendre's equation and Legendre's polynomials, power series method, extended power series method, Bessel functions.
3. Acquire advanced knowledge in Laplace transform and its applications in control engineering
4. Acquire advanced knowledge in linear algebra and vector calculus
5. Acquire advanced knowledge in matrix eigenvalues problems, including the determination of eigenvalues and eigenvectors

Syllabus

Ordinary differential equations and systems of differential equations. Series solutions to ordinary differential equations. Legendre's equation and polynomials, power series and Bessel functions. Laplace transform and its applications. Vector Calculus. Matrices and matrix eigenvalues and eigenvector problems.

Textbooks

Kreyszig, Erwin - Advanced Engineering Mathematics, John Wiley, 2011

Zill, D.G. and Cullen, M., Advanced Engineering Mathematics, 3rd ed., Jones & Bartlett Publishers Inc., 2006

References

Zill, D.G., Cullen, M. - Advanced Engineering Mathematics, 6th Edition, Jones & Bartlett Publishers, 2016.

Steward, James – Calculus, Early Transcendentals, Seventh Edition, Brooks Cole, Toronto, 2012

Mauch, Sean – Advanced Mathematical Methods for Scientists and Engineers, California Institute of Technology, 2002

Anton, Howard – Calculus, Sixth Edition, John Willey and Sons, New York, 1999

Assessment

Continuous Assessment:	60%
Final Examination:	40%

MM 502: ADVANCED ENGINEERING MATHEMATICS 2

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes

On completion of the subject, the student should be able to:

1. Proficient in vector differential calculus, including: vector and scalar functions and their fields. Curves, arc length, curvature, torsion. Gradient and divergence of scalar fields. Curl of vector fields.
2. Acquire knowledge in vector integral calculus, including integral theorems. Double integrals and Green's theorem in plane. Surface integrals. Triple integrals and Gauss theorem of divergence. Stokes's theorem.
3. Acquire knowledge in Fourier analysis and partial differential equations
4. Acquire knowledge in complex analysis. Cauchy-Riemann equations. Laplace equation.
5. Acquire knowledge in complex integration. Cauchy integral theorem and Cauchy integral formula. Power series, Taylor and MacLaurin series. Residue integration. Riemann surfaces.
6. Acquire knowledge in advanced probabilities and statistics

Syllabus

Vector differential calculus. Curves, arc length, curvature, torsion. Gradient and divergence of scalar fields. Curl of vector fields. Vector integral calculus, including integral theorems. Fourier analysis and partial differential equations. Complex analysis. Cauchy-Riemann equations. Laplace equation. Complex integration. Cauchy integral theorem and Cauchy integral formula. Power series, Taylor and MacLaurin series. Residue integration. Riemann surfaces. Conformal mapping, Schwarz-Christofel transformation, Joukowski transformation. Advanced probabilities and statistics. Probability distributions. Binomial, Poisson, hyper geometric and normal distributions

Textbook
Kreyszig, Erwin - Advanced Engineering Mathematics, John Wiley, 2011

References
Zill, D.G., Cullen, M. - Advanced Engineering Mathematics, 6th Edition, Jones & Bartlett Publishers, 2016.
Steward, James – Calculus, Early Transcendentals, Seventh Edition, Brooks Cole, Toronto, 2012
Mauch, Sean – Advanced Mathematical Methods for Scientists and Engineers, California Institute of Technology, 2002
Anton, Howard – Calculus, Sixth Edition, John Willey and Sons, New York, 1999

Assessment
Continuous Assessment:	60%
Final Examination:	40%

MM 503: NUMERICAL METHODS (4/0/0)

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to:

1. Find roots of equations and polynomial equations and polynomial equations of higher order
2. Solve linear and nonlinear differential equations
3. Find eigen values, approximations of functions and their integration
4. Solve common partial differential equations
5. Interpolate polynomials

Syllabus
Roots of a function: Bisection, fixed point, Newton methods, Secant and Regula Falsi. Roots of polynomial equations.
Polynomial Interpolation: Lagrange polynomial, Neville's method, divided differences, Hermite polynomial and splines.
Numerical differentiation and Numerical Integration: Richardson's extrapolation, Trapezoidal rule and Simpson's rule, Newton-Cotes Integration Formulas, Gaussian quadrature.
Solution of linear systems of equations: Gauss elimination method, computation of matrix inverse, LU decomposition.
Eigen value problems: Power method, Householder algorithm, QR algorithm.
Approximation of Functions: Taylor polynomial, Chebyshev polynomial, least square approximation, rational approximations.
Numerical solution of ordinary differential equations: Euler algorithm, Taylor algorithms, Runge-Kutta Methods, predictor-corrector method.
Solution of Partial Differential Equations: Hyperbolic equations, parabolic equations, elliptic equations.

Textbook
Richard L. Burden and J. Douglas Faires, Numerical analysis, 10th Ed., Brooks/Cole Cengage Learning, Boston, 2015.

Reference
Chapra, S.C. and R.P. Canale, Numerical Methods for Engineers, 7th Ed, McGraw-Hill, Inc., 2015.

Assessment
Continuous assessment	60%
Written Examination	40%

MM 504: RESEARCH METHODOLOGY AND COMPUTATION

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to:

1. Apply research methodology
2. Use the computer applications for use in independent study and research
3. Acquire knowledge and skills in designing experiments, simple comparative experiments, sampling and confidence Intervals
4. Acquire skills in factorial design of experiments, including fitting regression models
5. Develop knowledge and skills regarding numerical approaches in research methodology

Syllabus
Elements of an experimental test set-up. Basic instrumentation. Data acquisition system. Data

analysis. Hypothesis formulation. Designing questionnaire. Hypothesis testing. Statistical analysis and interpretation of data. Writing and presentation of technical reports. Bibliography and references. Presentation techniques to an audience.
Different types of computers: Computer types, micro-processors and their principle of operation. Different input/output devices. Different types of computer memory. Disk operating systems. High-level languages. Software. Application of computers in solving engineering problems. Computer-Aided Engineering.

Textbook
Holman, J.P., Experimental Methods for Engineers, 8th ed., McGraw-Hill, 2012.

Reference
Mitra, A., Fundamentals of Quality Control and Improvement, 4th Edition, Wiley, 2016.

Assessment
Continuous assessment 60%
Written Examination 40%

MM 505: DISSERTATION

Total Hours 44

Common Credit: 66

Learning Outcomes
On completion of the Research Project, the student should be able to:

1. Identify the main activities of a typical engineering product, process or system
2. Plan a detailed schedule of activities to complete and meet the project deadline
3. Apply the engineering principles learnt in other subjects in the development of the project work
4. Develop effective communication skills including listening, oral and written presentations and the ability to handle Q/A sessions
5. Write a dissertation on the project work

Syllabus
This course involves a project given to each student as an independent study for which lecturers will provide guidance. Topics of research project will be chosen in consultation with supervisors in areas relevant to PNG conditions. Candidates are expected to prepare objectives of the project, review the literature, propose the methodology of research, and initiate and conduct the research work required. The candidate is expected to present results of the research in the form of a dissertation.

Assessment
Continuous assessment and submission of a dissertation - 100%

MM510: ADVANCED MACHINE DESIGN (4/0/0)

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to:

1. Develop analytical skills in machine element design
2. Design simple machines and components
3. Apply the fundamentals of product planning development
4. Acquire knowledge on material selection and Static Stresses on elements of machinery, finite element modelling and experimental approaches on fracture mechanics
5. Familiarize with failure theories, safety factors and reliability in machine design

Syllabus
The scope of design: fundamentals of engineering systems and systematic approach; the design process;
product planning; product specification; conceptual design; search for solutions; methods of analysis; choosing the best design; product design; reliability; design project (preferably from industry).

Textbook
Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H. Engineering Design, Springer-Verlag, 3rd Edition, 2007

Assessment
Continuous assessment 60%
Written Examination 40%

MM511: MATERIALS HANDLING SYSTEMS

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes

On completion of the subject, the student should be able to:

1. Analyse and design integrated material handling systems for automatic storage and retrieval of unit loads
2. Specify key parameters for such systems
3. Analysis on manufacturing cycle time
4. Knowledge on delays and damage
5. Promote safety and improve working conditions
6. Promote productivity

Syllabus

Analysis and design of integrated material handling systems; automatic storage and retrieval of unit loads, and identifying and establishing boundary conditions on key parameters required to specify the desired system required for equipment vendors to design appropriate hardware.

Textbooks

Roger L. Brauer, Safety and Health for Engineers Tolono, Illinois, 2nd Edition, A John Wiley & Sons, Inc, Publication.

Assessment

Continuous assessment	60%
Written Examination	40%

MM512: COMPUTER-AIDED DESIGN

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes

On completion of the subject, the student should be able to:

1. Describe the key characteristics of a feature-based, parametric solid modeler. Identify the principal components of a modern 3D CAD software user interface. Explain how different dimensioning methodologies serve different design intents. Creation of fully defined sketches.
2. Create a new part. Insert a new sketch and add sketch geometry. Establish sketch relations between pieces of geometry. Understand the state of the sketch. Creation of fully defined sketches. Use sketch tools to add fillets. Extrude the sketch into a solid.
3. Perform basic part modeling. Boss and cut extrusions. Hole wizard, fillets, basic drawings, dimension changes. Associativity between solid models and drawings.
4. Perform solid modeling for casting and forging. Feature parameter editing.
5. Create linear, circular and mirror patterns.
6. Create revolved and sweep features. Select materials for solid models and calculate physical properties of solid models: mass, center of gravity, inertial moments.
7. Create shellings and ribs. Edit for repairs and design changes. Edit part configurations.
8. Create design tables and equations. Use existing design tables to create families of parts.
9. Create bottom–up assemblies. Add mating relationships between parts in assembly. Explore mass properties and detect interference. Create exploded views. Create bills of materials for assemblies.

Syllabus

The subject introduces students to the modern approach of 3D CAD for generating and analysing solid models and assemblies on computers. The included topics address theoretical and practical aspects encountered in the creation, modification, analysis, and optimization of mechanical engineering design. Also included are topics dealing with the creation of technical drawings, generation of bills of materials.

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Textbook

Dassault Systems – SolidWorks Fundamentals, Concord, Massachusetts, United States, 2012.

Assessment

Continuous assessment	60%
Final Examination	40%

MM 513: FINITE ELEMENT METHOD

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to understand and apply:

1. Partial differential equations governing the behavior of deformable bodies.
2. Fundamental relations for linearly elastic solids and the importance of stress matrix in finite element method.
3. The finite element method. Interpolation functions. Isoperimetric elements.
4. Numerical and reduced integration. Solutions for simultaneous linear equations and stress calculations
5. Vibration modes and frequencies. Variational principles. Solution for linear eigenvalues problems. Buckling and variational principles for buckling.
6. Matrix form for heat transfer equations. Variational statement and the finite element method. Numerical solution for transient heat conduction.
7. Physical capabilities of flow simulation
8. Governing equations in CFD. Navier-Stokes equations. Conjugate heat transfer. Radiation heat transfer between solids.
9. Flows in porous media and Boundary conditions

Syllabus
Partial differential equations in governing the behavior of deformable bodies. Fundamental relations for linearly elastic solids and the importance of stress matrix in finite element method. Strain matrix and stress-strain relationships. The principle of minimum potential energy. Strain energy relationships for beams, plates and shells. The finite element method. Interpolation functions. Isoparametric elements. Numerical and reduced integration. Solutions for simultaneous linear equations and stress calculations. Vibration modes and frequencies. Variational principles. Solution for linear eigenvalues problems. Buckling and variational principles for buckling. Matrix form for heat transfer equations. Variational statement and the finite element method. Numerical solution for transient heat conduction. FEM libraries. Physical capabilities of flow simulation. Governing equations in CFD. Navier-Stokes equations. Conjugate heat transfer. Radiation heat transfer between solids. Flows in porous media. Boundary conditions. Numerical solution technique. Examples and validation problems

Textbooks
Dassault Systems – SolidWorks Simulation, Concord, Massachusetts, United States, 2012.
Reddy, J.N. - Introduction to Finite Element Method, Third Edition, McGraw-Hill, Inc., 2006.

Reference
Logan, D. L., A First Course in Finite Element Method, 6th Ed., Cengage Learning US, 2016

Assessment
Continuous assessment	60%
Final Examination	40%

MM514: ADVANCED VIBRATION

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to:

1. Explain principles of mechanical vibrations.
2. Define and describe the concepts of vibration modes and natural frequencies and their measurement and estimation for multi-degree-of-freedom systems
3. Analyse mechanical vibration in random vibration, non-linear vibrations and vibration of continuous systems
4. Model free vibrations of single degree of freedom systems
5. Acquire proficiency in analysing harmonically excited vibrations
6. Recognise difficulties in modelling multiple degrees of freedom vibrations
7. Determine natural frequencies, mode shapes, vibration, measurement and analysis.

Syllabus
This course may be offered in any of the following topics depending on the requirements of attending students:

Mechanical Vibrations and Experimental Methods in Vibrations: Linear theory of

Vibrations of finite number of degrees of freedom systems via languages equations Sensors, instruments, measurements techniques data acquisition methods; data reduction methods for vibration measurement and modal analysis; applications including turbo machinery blades, vanes, gears, bearings and rotors; structures such as beams, frames and machine foundations.

Continuous systems: Introduction to continuous systems; vibration of strains, longitudinal vibration of rods, torsional vibration of rods; beam vibration, effect of rotary inertia and shear de-function; vibration of the plates.

Random vibrations: Random phenomena, defining expected value, frequency responses function, probability distribution, correlation of signals, power spectrum, power spectral density, Fourier Transform, response of single and multi-degree systems to stationary random excitations.

Nonlinear vibrations: Introduction to nonlinear vibration, exact methods of solution, approximates analytical methods, graphical methods, stability of equilibrium, numerical methods.
Vibration measurement and control common to all topics.

Textbook

Rao, S. – Mechanical Vibrations, 5th Edition, Prentice Hall, New York, 2011

References

Gans, R.- Mechanical Systems - A Unified Approach to Vibrations and Controls, Springer, 2015
Thomson, W., Dahleh, M. - Theory of Vibrations with Applications, 5th Edition, Prentice Hall, 1998

Assessment

Continuous assessment 60%
Written Examination 40%

MM515: NOISE CONTROL ENGINEERING

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes

On completion of the subject, the student should be able to:

1. Apply basic concepts of the nature of sound and noise to engineering students
2. Conduct measurements and analyses required to diagnose noise and vibration problems and develop meaningful solutions;
3. Develop and apply methods for the control of noise and vibration in most situations;
4. Know when outside consultation is required for solving complex noise and vibration control problems and how to utilize consultants effectively

Syllabus

The nature of sound; units; sound measurements; instruments; effects of noise on people; hearing loss; noise and law; near and far field noise; acoustics of rooms and enclosures, noise analysis; noise criteria; damping of panels; principles of noise control: vibration isolation, noise source identification and their relative importance, noise control procedures applicable to source, path and receiver; case studies: cooling fan, mine ventilation fan noise, duct noise, material handling impact noise, engine noise, turbine noise, jet noise; factory noise, industrial noise control programme.

Textbook

David A. Bies and Colin H. Hansen, Engineering Noise Control, Theory and Practice, 3th Edition University of Adelaide, Australia, 2003.

Reference

Lord, H.W.,et. al., Noise Control for Engineers, McGraw Hill Book Company, 1980.

Assessment

Continuous assessment 60%
Written Examination 40%

MM520: COMPUTER-INTEGRATED MANUFACTURING

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to:

1. Understand the concepts of computer integrated manufacturing
2. Recognise constituent parts of CIM systems and integration of the parts to form a system
3. Achieve Advanced Understanding Regarding CNC Systems in Advanced Precision Manufacturing
4. Master Software Platforms for CNC Manufacturing, Including Tool Path Optimization of 3D CAD Models of Parts
5. Acquire Advanced Understanding Regarding Maintenance Issues in Computer Integrated Manufacturing Develop an understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques.
6. Develop an understanding of computer-integrated manufacturing (CIM) and its impact on productivity, product cost, and quality.

Textbook
Kalpakjian, S. and S. Schmid, Manufacturing Engineering and Technology, 6th ed., Prentice Hall, 2010.

Assessment
Continuous assessment 60%
Written Examination 40%

MM521: CONVENTIONAL MANUFACTURING TECHNOLOGY

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to:

1. Understand relevant fundamentals and real-world practices of advanced manufacturing process
2. Understand inter relationships among technical and economic factors involved
3. To acquire knowledge gain on forming processes for engineering materials
4. Develop strategies for the safe and effective utilizations of human resources materials, and manufacturing methods.

Syllabus
Powder metallurgy; forming and shaping plastics and composite materials; non-traditional machining processes - chemical machining, electrochemical machining, electrochemical grinding, electrical-discharge machining, travelling-wire electrical- discharge machining, laser-beam machining, electron-beam machining, hydrodynamic machining; economics of non-traditional machining processes; joining processes and equipment - oxyfuel gas welding, arc-welding processes, consumable and non-consumable electrodes, resistance welding processes; surface technology; competitive aspects and economics of manufacturing - selection and substitution of materials, selection of manufacturing processes, manufacturing costs and value engineering.

Textbook
Kalpakjian, S. and S. Schmid, Manufacturing Engineering and Technology, 6th ed., Prentice Hall, 2010.

Assessment
Continuous assessment 60%
Written Examination 40%

MM522: ROBOTICS IN MANUFACTURING

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to:

1. Understand industrial robots
2. Understand their mechanical elements, sensory systems, and control systems and their use in manufacturing

3. Acquire advanced knowledge on impact of robots, control engineering systems and mechatronics in engineering and economy
4. Understand the relationship between software development, component design, sensor and servo system in both stationary and autonomous robots.
5. Acquire skills and experience in developing autonomous robots, including visual programming development, sensor and servo system selection and component design
6. Acquire advanced knowledge on applications of robots in industrial engineering and operations management

Syllabus
Robotic mechanical systems and their general architecture. Types of robots by function, size and application. Manipulators: robotic arms and hands. Motion generator. Parallel and SCARA robotic systems. Locomotors: Legged and wheeled robots. Swimming and flying robots. Mathematical background in robotics. Fundamentals of rigid-body mechanics. Geometry and kinetostatic of serial robots. Trajectory planning. Pick and place operations. Dynamics of serial robots. Dynamics of complex robots. Visual programming of robots.

Textbooks
Angeles, J. – Fundamentals of Robotic Mechanical Systems, Mechanical Vibrations, 3rd Edition, Springer Science, New York, 2007
James A. Rehg, Introduction to Robotics in CIM Systems, 5th edition, Upper Saddle, River, NJ: Prentice Hall, 2003.

References
Corke, P. – Robotics, Vision and Control. Fundamental Algorithms in Matlab, Springer Science, Heidelberg, Germany, 2011
B. Benhabib, Manufacturing: Design, Production, Automation and Integration, New York: Marcel Dekker, 2003.

Assessment
Continuous assessment 60%
Written Examination 40%

MM523: JUST-IN-TIME SYSTEM

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to:

1. Understand the basic philosophies of JIT system
2. Gain sufficient understanding for implementation of JIT in a manufacturing industry.
3. Apply JIT principles to reduce lead time in any organization.
4. Propose methods to eliminate obstacles of JIT for any organization

Syllabus
Brief history of Just-In-Time system; definition, objectives and benefits of JIT; basic philosophies; key elements of JIT; Push and Pull Systems; Kanban; Kanban rules; inventory control under JIT; reduction of lead time, reduction of set-up time, standard operations; machine layout in JIT, multifunctional workforce, job rotation, training requirements; improvement activities;
Autonomous defects control; functional management and its organization; adapting to JIT system, obstacles; future development of JIT system. Applications of Lean Approaches and Methodologies.

Textbook
Louis. R.S., Integrating Kanban with MRP II: Automating a Pull System for Enhanced JIT Inventory Management, 1st Edition, CRC Press, 2005

Reference
Monden, Y., Toyota Production System: An Integrated Approach to Just-In-Time, 4th Edition, CRC Press, 2011

Assessment
Continuous assessment 60%
Written Examination 40%

MM524: ADVANCED QUALITY CONTROL

Hours per week: 4 (4/0/0)

Common Credit: 18

Prerequisite: Knowledge of statistics.

Learning Outcomes

On completion of the subject, the student should be able to:

1. Understand both classical and advanced acceptance sampling methods
2. Gain in depth understanding of statistical process control methods
3. Understand, conduct and analyze comparative experiments
4. Understand and apply control charts for analysis of observational data
5. Design and conduct screening experiments, including graphical analysis.
6. Design, conduct and analyse complete factorial

Syllabus

Advanced methods applied to quality control. Acceptance sampling plans from the classical lot attribute plan to sophisticated multi-lot dependent plans. Classical treatments and recent developments in process control. Evaluation, design and maintenance of quality control programs.

Textbook

Montgomery D.C, Introduction to Statistically quality control, John Wiley & Sons, Inc. 7th Edition, 2015

Reference

Mitra, A., Fundamentals of Quality Control and Improvement, 4th Edition, Wiley, 2016.

Assessment

Continuous assessment 60%
Written Examination 40%

MM 525: PLANNED PREVENTIVE MAINTENANCE

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes

On completion of the subject, the student should be able to:

1. Understand the principles, functions and practices adapted in industry for the successful management of maintenance activities.
2. Explain the different maintenance categories like Preventive maintenance, condition monitoring and repair of machine elements.
3. Design a maintenance schedule for some maintenance activities.
4. Analyse and develop cost effective maintenance alternatives
5. Understand the use of simple instruments used for condition monitoring in industry

Syllabus

Maintenance fundamentals; systematic approach to maintenance; maintenance economics; maintenance organization; origin of maintenance problems; inspection and maintenance tools; inspection and lubrication schedules; condition monitoring; repair methods for basic machine elements; repair methods for material handling equipment; maintenance records; maintenance inventory examples of maintenance of elements and machines; maintenance planning; scheduling; manual vs computer assisted maintenance; motivation of workforce; implementation of maintenance programme.

Textbooks

Davies A., Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2018
Mobley K., Maintenance Engineering Handbook, 8th Edition, McGraw Hill, 2013

References

Richard Palmer, «Maintenance Planning and Scheduling Handbook», 2013, McGraw-Hill.
Patton., J.D. Preventive Maintenance, 3rd Edition ISA-The Instrumentation, Systems, and Automation Society, 2004

Assessment

Continuous Assessment 60%
Final Examination 40%

MM530: INTERNAL COMBUSTION ENGINES

Hours per week: 4 (4/0/0)

Common Credit: 18

Learning Outcomes

On completion of the subject, the student should be able to:

1. Apply principles of relevant fields of study in basic design considerations of the system
2. Demonstrate ability to modifications to the design of some systems

4.Understand advanced concepts of the combustion process
5.Perform calculations for the design of engines and selection of equipment

Syllabus

Types and arrangements; theoretical gas cycles; combustion thermodynamics; actual gas cycles - dynamometers, fuel and air flow, exhaust gas analysis; air, fuel, and exhaust flows - pumping and scavenging work, carburetion, fuel injection, measurement techniques; combustion and emissions - auto ignition, nitrogen oxides, carbon monoxide, hydrocarbons, particulates, emission control and legal requirements; fuel technology - gasoline, diesel fuel, fuel additives; engine performance - criteria, testing, critical factors.

Textbook

Ferguson, C.R, Kirpatrick., Internal Combustion Engines: Applied Thermosciencess, 3rd Ed, 2015 , Wiley.

Assessment

Continuous assessment 60%
Final Examination 40%

MM 531: GAS TURBINES

Hours per week: 4 (4/0/0)
Common Credit: 18

Learning Outcomes

On completion of the subject, the student should be able to:

1. Demonstrate thorough knowledge on different types of compressors
2. Estimate performance parameters for different types of gas turbines and gas turbine arrangements
3. Demonstrate a thorough knowledge of gas turbines on power plants, air and marine transportations.
4. Demonstrable knowledge on combustion chamber
5. Demonstrate a thorough knowledge on gas turbine limitations. Selection of materials, parts and components

Syllabus

Gas turbine principles of operation. Single-shaft and multi-spool arrangements. Aircraft propulsion. Shaft power cycle (ideal). COGAS cycles and cogeneration schemes. Gas turbine cycle for aircraft propulsion: simple turbojet cycle, turbofan engine, turboprop engine, thrust augmentation. Axial and centrifugal compressors: theory, factors affecting pressure ratio, degree of reaction, compressor map and characteristic. Combustion systems: Factors affecting combustion, combustion process, combustion chamber performance. Prediction of performance of simple gas turbines. Gas turbines, components and their principles of operation. Industrial gas turbine engines.

Textbook

Cohen, H., et al, Gas Turbine Theory, Saravanamuttoo H I Rogers G F C, Cohen H, Straznicky,6th Ed. 2009, Pearson Education Ltd.

Assessment

Continuous assessment 60%
Final Examination 40%

MM532: HYDRAULIC MACHINES

Hours per week:4 **(4/0/0)**

Common Credit: 18

Learning Outcomes

On completion of the subject, the student should be able to:

1. Analyse the fluid flow in hydraulic machines
2. Design rotodynamic machinery and their components
3. Select pumps and turbines for industrial applications
4. Demonstrate thorough knowledge on vibration and noise and causes in hydraulic machines
5. Acquire knowledge on controls of power, pressure and flow in hydraulic machines

Syllabus

System analysis for pump selection, specific speed and modelling laws, specific speed charts; design considerations for various applications; impeller design - impeller layout, development of impeller vane; volute design, double and triple volute casing design, circular volute; design of multi-stage casing; double-suction pumps and side-suction design; pump applications - vertical pumps, wet-pit pumps, barrel-mounted pumps, slurry pumps, pumps for chemical processes; hydraulic turbines - selection process, turbine performance prediction, fixed guide vane turbines, variable guide vane turbines; pump and turbine components - mechanical seals, bearings and lubrication; gear pumps and vane pumps; compressors - types and design considerations; vibration and noise - causes of vibration, cavitation, diagnosis of pump vibration problems; controls - constant power control, constant pressure control, constant flow control.

Textbook
Wright, T, Gerhart, P, Fluid Machinery: Application, Selection and Design, 2nd Ed. 2009, CRC Press.

Reference
Lobanoff, V.S., & Ross, R.R., Centrifugal Pumps - Design & Applications, Gulf Publishing Company, 1992.

Assessment
Continuous assessment 60%
Final Examination 40%

MM533: ADVANCED HEAT TRANSFER

Hours per week:4 **(4/0/0)**

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to:

1. Demonstrate the ability to solve heat exchanger problems
2. Solve multi-dimensional conduction problems
3. Demonstrate the ability to solve problems involving one or more modes of heat transfer
4. Make right assumptions and approximations for tackling practical situations
5. Analyse complex heat transfer problems

Syllabus
Steady-state heat conduction in one, two, and three dimensions - graphical and numerical methods; unsteady-state heat conduction - chart and numerical methods; convection - review, dimensional analysis, boundary layer analysis, Reynolds' analogy, free convection, forced convection inside tubes and over exterior surfaces; heat exchangers - types and arrangements, LMTD and effectiveness methods of analysis, fouling factors, selection; radiation - review, gas-filled enclosures, combined modes with conduction and convection; boiling heat transfer, condensing heat transfer.

Textbook
Incropera F. P., DeWitt D. P., Bergman T. L. and A. S. Lavine, Fundamentals of Heat and Mass Transfer, 8th Ed., 2017 Willie Plus

Assessment
Continuous assessment 60%
Final Examination 40%

MM534: RENEWABLE ENERGY

Hours per week:4 **(4/0/0)**

Common Credit: 18

Learning Outcomes
On completion of the subject, the student should be able to:

1. Discuss different types of renewable energy sources
2. Discuss the technologies for renewable energy utilisation and conversion
3. Explain the economics of renewable energy conversion devices
4. Conduct feasibility and design studies for selected renewable energy technologies
5. Discuss national and international trends and protocols

Syllabus
Range of renewable energy resources and its potential; selected technologies generally recognized as being the most feasible technically and economically, e.g., solar (both thermal and photo-voltaic), wind, hydro, tidal, waste and bio-mass; methods of harnessing and using energy from these sources, including hybrid systems; limitations of renewable energy harnessing; principles of energy conversion; storage and transfer for renewable energy systems; feasibility and design studies for selected renewable energy technologies; national and international trends.

Textbook
Jefferson W Tester, Elizabeth M Drake, Michail J Discoll, Michael W Golay, William A Peters,

Sustainable Energy: Choosing Among Options", 2nd Ed 2012, MIT Press.

References

Godfrey Boyle, Renewable Energy Power for a sustainable Future, 2004, Oxford University Press, in association with the Open University.
Dunn, P.D., Renewable Energy Sources, Conservation & Application, Peter Peregrinns Ltd, 1986.

Assessment

Continuous assessment 60%
Final Examination 40%

MM535: FOSSIL FUELS & COMBUSTION TECHNOLOGY

Hours per week:4 **(4/0/0)**

Common Credit: 18

Learning Outcomes

On completion of the subject, the student should be able to:

1. Discuss different types of fossil fuels and methods for their exploration and production
2. Acquire knowledge of combustion equipment
3. Apply combustion technology to combustion equipment to improve efficiency
4. Discuss limitations of solid fuels to be used on gas turbine applications and the importance of updating on latest technological developments
5. Discuss Impacts of products of combustion to the environment and its mitigation

Syllabus

Different types of fossil fuels, geographic spread of reserves, life-span, processes involved from exploration to production; grades of fuels; impurities; processes involved in refining the fuels; thermochemical reactions and combustion of fossil fuels on theoretical and practical bases; theory of combustion and brief introduction to combustion kinetics; air supply in combustion; by-products of fuel production and combustion; control of combustion processes; pulverized fuel combustion; fluidized-bed combustion; environmental control systems; particulate emissions; particulate and sulphur dioxide removal; scrubbers.

Textbook

Sarkar S, Fuels and Combustion, 3rd Ed., 2009, Universities Press, India

Reference

Fransis, W, Peters M C, Fuels and Fuel Technology, 1980, 2nd Ed., Elservier

Assessment

Continuous assessment 60%
Final Examination 40%

MM536: REFRIGERATION & AIR-CONDITIONING

Hours per week:4 **(4/0/0)**

Common Credit: 18

Learning Outcomes

On completion of the subject, the student should be able to:

1. Acquire knowledge on energy conservation and its incorporation in refrigeration and air conditioning industries
2. Demonstrate the ability to make right assumptions and approximations for tackling practical problems
3. Describe air conditioning and refrigeration materials and equipment
4. Demonstrate the ability to perform heat load calculations and select appropriate A/C devices
5. Demonstrate the ability to perform ducting requirements and designing a complete air conditioning and distribution systems

Syllabus

Air cycle; body comfort; psychometric chart and processes; principles of heat load estimation for air-conditioning systems; types of air-conditioning equipment; air distribution; ducts; residential and commercial air-conditioning; air-conditioning equipment; refrigerants; types of refrigeration systems; food, and growth of micro-organisms; basic principles of heat transfer; latent heat; calculation of heat load; insulation; evaporator; condenser design; compressors; charging and testing of refrigeration systems; basic refrigeration controls; electrical components.

Textbook

Australian Refrigeration and Air Conditioning Vol 1 and 2, AIRAH 2016.

References

Jones, W.P., Air-conditioning Engineering, 5thEd., 2001 Spon Press.
DA09 Air Conditioning Load Estimation, AIRAH, 1998 [AIRAH Document]

Assessment

Continuous assessment	60%
Final Examination	40%