THE DYSON INSTITUTE

Module Information for 2021

Year two

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Module information	
Year 2	
Name of module	**Engineering Mathematics and Technical Computing**
Module description	To present and provide skills in the application of more advanced mathematics and systems modelling concepts that underpin many areas of Engineering. To build on the fundamental material introduced in the year 1 Engineering Mathematics and Systems module and introduce more advanced topics related to the analysis of a wide variety of engineering systems. To consolidate the development of problem solving and modelling skills as required in other Year 2 modules and that students are equipped with the skills to tackle advanced material in modules taught in later years.
Outline syllabus	• Series and limits • Fourier Analysis • Laplace Transforms • Differentiation and integration of functions of two or more variables • Vector calculus • Partial differential equations
Method of assessment and weighting attributed to each area of assessment	80% Unseen Examination (3 hours) 20% Assignment (1000 words)

Name of module	Applied Programming 2
Module description	Building on the module Applied Programming1, this module aims to enhance students' programming skills using both Matlab and Python. It will give an insight in the underlying theory to a range of engineering problems and give experience on how to apply MATLAB/ SIMULINK features for analysing them. The module will familiarise students with theoretical and practical aspects of data acquisition, data analysis and signal processing, thus developing the skills to create appropriate simulation models of dynamical systems. It will also introduce students to the Object-Oriented programming and event-driven method of GUI development. Finally, students will be introduced to team software development techniques, such as the use of GIT for version-control and for tracking changes in source code during software development.
Outline syllabus	• Introduction to Object Oriented Programming (OOP) • Graphical User Interface (GUI) • Data Acquisition • Data Analysis and Signal Processing • Simulink • Software development and team software development tools
Method of assessment and weighting attributed to each area of assessment	40% Test (1 hour) 60% Project (1500 words + presentation)

Name of module	**Digital Systems and Computer Architecture**
Module description	The module aims to provide students with an understanding of digital systems and their applications. It puts them into context as core components of computer architectures. The main focus is to understand digital systems and low-level computer architecture elements such as memories, arrays, I/O, and processes. It also shows the interconnection and role of the various layers from device, through assembler, to programming and communication with other devices or systems.
Outline syllabus	• Digital devices • Digital logic • Combinational Circuits • Sequential circuits • Processor elements • Registers and memories • Memories and components • Digital System Arrays (Multiplexers, demultiplexers, decoders, programmable logic arrays, FPGA, ASIC) • Assembler • I/O systems • A/D – D/A conversion • Processes and communications (e.g. Kernel) • Modern processor architectures • Performance enhancing techniques • Applications • Low level debugging
Method of assessment and weighting attributed to each area of assessment	60% Unseen Examination (2 hours) 20% Group Report (1800 words) 20% Individual Report (800 words)

Name of module	Control Systems
Module description	This module aims to develop an understanding of the main techniques for modelling, analysis and design of practical continuous-time control systems. It covers the underlying concepts and applications of control theory to engineering systems, with particular emphasis on electromechanical systems. The case studies underpin the usage of well-established analytical techniques for estimating the behaviour of single-input single-output systems under both steady-state and transient conditions.
Outline syllabus	• Basic concepts of control • Sensors, controllers, actuators • Principles of open- and closed-loop control, standard signals in control • Modelling: time domain, Laplace domain • Transfer functions • Stability analysis • Bode and Nyquist diagrams and stability analysis • Performance in steady-state and transient operation • P, I, D, PI, PID controllers and their application • Practical Implementations (e.g. noisy inputs, output signals, etc.) • Compensators • Cascade control • Introduction to state space systems modelling • Dynamic behaviour from standard tests (specs)
Method of assessment and weighting attributed to each area of assessment	60% Unseen Examination (2 hours) 20% Individual Report (800 words) 20% Group Report (1800 words)

Name of module	Mechanics II: Dynamics and Vibration
Module description	This module aims to provide covers the underlying concepts and applications of dynamics and vibration and how these apply to engineering systems. The course covers topics in dynamics mechanics including different types of motion (linear, circular, and projectile); force, momentum and impulse; bodies in rotation; work and power; torque, angular momentum and energy; and vibration.
Outline syllabus	• **Introduction to dynamic mechanics, rectilinear and curvilinear motion** • **Motion of projectile, dependent and relative motion** • **Kinetics of a particle** o Force and acceleration, equation of motion o Work and energy for particles, power and efficiency o Linear and angular impulse and momentum o Dynamics of Particles o Importance and applications in rigid bodies o Difference between kinematics and kinetics • **Planar Kinematics of a Rigid Body** o Planar Rigid-Body Motion o Translation o Rotation about a Fixed Axis o Absolute Motion Analysis o Relative-Motion Analysis: Velocity o Instantaneous Centre of Zero Velocity o Relative-Motion Analysis: Acceleration o Relative-Motion Analysis using Rotating Axes • **Planar Kinetics of a Rigid Body: Force and Acceleration** o Moment of Inertia o Planar Kinetic Equations of Motion o Equations of Motion: Translation o Equations of Motion: Rotation about a Fixed Axis o Equations of Motion: General Plane Motion • **Planar Kinetics of a Rigid Body: Work and Energy** o Kinetic Energy o The Work of a Force o The Work of a Couple o Principle of Work and Energy o Conservation of Energy • **Planar Kinetics of a Rigid Body: Impulse and Momentum** o Linear and Angular Momentum o Principle of Impulse and Momentum o Conservation of Momentum o Eccentric Impact

	• Vibrations o Undamped Free Vibration o Undamped Forced Vibration o Viscous Damped Free Vibration o Viscous Damped Forced Vibration
Method of assessment and weighting attributed to each area of assessment	60% Unseen Examination (2 hours) 20% Assignment (600 words per group member) 20% Lab (600 words per group member)

Name of module	Fluid Dynamics
Module description	The overall module aim is to develop the abilities to understand, model and analyse heat transfer and fluid flow and apply these to engineering systems. The module incorporates two components of thermal fluid sciences - heat transfer engineering and fluid mechanics. The heat transfer component will cover different heat transfer modes, formulating them in order to analyse steady-state and transient behaviour of the bodies subjected to thermal gradients. Thermal resistance approach, heat capacity and the lumped mass approximation are dealt with by both analytical and numerical methods. The fluid mechanics component includes the flow properties, Newtonian and non-Newtonian fluids, the principles of conservation of mass and momentum, laminar and turbulent flows, pipe flows, flow resistance, friction and losses in pipes, ducts and fittings for case of fluids in motion.
Outline syllabus	• **Fluids** o Viscosity and shear rate; Newtonian vs. non-Newtonian; Reynolds number; mass continuity; Bernoulli equation; flow measurement (pitot, venture, and orifice). o Mass and momentum conservation; Euler flow; Stokes flow; Couette flow; Poiseuille flow. o Hagen-Poiseuille flow (in pipes). o Taylor series; differencing schemes; combined Couette Poiseuille flow using Crank-Nicolson; Assignment 1. o BL; laminar vs turbulent; BL thickness; viscous and form drag; influence of surface roughness; flow around a sphere/cylinder. o Dimensional analysis (DA). o Pipe flow with friction; friction factor and DW equation; pipe pressure loss (laminar/turbulent, surface roughness); Moody chart. o Minor losses in pipes; pressure/head loss; matching pumps to pipes. • **Heat transfer** o Heat transfer review (conduction, convection, and radiation); thermal resistance, critical radius of insulation. o Thermal diffusivity; heat equation; special cases; IC; BC. o Convection; HTC; natural vs forced convection; thermal BL; thermal entrance region; dimensionless numbers (Froude, Nusselt, Prandtl); Nusselt number for laminar and turbulent flow.

	o Numerical methods; 1D HT (matrix solution); 2D HT (matrix and iterative methods); assignment (2D HT in Matlab) – steady-state solution. o Transient heat conduction; lumped body analysis; large plane/cylinder spheres. o Semi-infinite solids; two semi-infinite bodies in contact. o Radiation (absorptivity, reflectivity, transmissivity); black bodies; Grey bodies; radiation between two or more surfaces. o Heat exchangers; different types of heat exchangers; analysis; LMTD.
Method of assessment and weighting attributed to each area of assessment	60% Unseen Examination (2 hours) 20% Assignment (600 words per group member) 20% Lab (600 words per group member)