**MODULE SPECIFICATION**

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|---|---|---|---|---|---|
| **Module Title:** | **Mechanical Science** | **Level**: | 4 | **Credit Value**: | 20 |

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|---|---|---|---|---|---|
| **Module code**: | ENG458 | **Is this a new module?** | No | **Code of module being replaced**: | |

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|---|---|---|---|
| **Cost Centre**: | GAME | **JACS3 code**: | H142 |

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|---|---|---|---|
| **Trimester(s) in which to be offered:** | 1, 2 | **With effect from:** | September 17 |

| | | | |
|---|---|---|---|
| **School:** | Applied Science, Computing & Engineering | **Module Leader:** | R.Bolam |

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|---|---|
| Scheduled learning and teaching hours | 60 hrs |
| Guided independent study | 140 hrs |
| Placement | 0 hrs |
| **Module duration (total hours)** | 200 hrs |

| **Programme(s) in which to be offered** | Core | Option |
|---|---|---|
| BEng (Hons) Aeronautical and Mechanical Engineering | ✓ | ☐ |
| BEng (Hons) Mechanical Manufacturing | ✓ | ☐ |
| BEng (Hons) Automotive Engineering | ✓ | ☐ |
| BEng (Hons) Drone Technology and Operations | ✓ | ☐ |
| BEng (Hons) Renewable Energy and Sustainable Engineering | ✓ | ☐ |
| BEng (Hons) Electrical and Electronic Engineering | ✓ | ☐ |
| BEng (Hons) Applied Product Design | ✓ | ☐ |
| BEng (Hons) Automation Engineering | ✓ | ☐ |
| BEng (Hons) Optoelectronics and Holography | ✓ | ☐ |
| BEng (Hons) Aerospace and Modern Optics | ✓ | ☐ |

Office use only
Initial approval February 17
APSC approval of modification Version 1
Have any derogations received Academic Board approval? Yes ✓ No ☐

| **Module Aims** |
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| 1. To insure the student understands and is able to apply the principles of solid mechanics to solve problems in practical situations.<br>2. To insure the student understands and is able to apply the principles of fluid mechanics to solve problems in practical situations.<br>3. To insure the student understands and is able to apply the principles of thermodynamics to solve problems in practical situations. |

**Intended Learning Outcomes**

Key skills for employability

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|---|---|
| KS1 | Written, oral and media communication skills |
| KS2 | Leadership, team working and networking skills |
| KS3 | Opportunity, creativity and problem solving skills |
| KS4 | Information technology skills and digital literacy |
| KS5 | Information management skills |
| KS6 | Research skills |
| KS7 | Intercultural and sustainability skills |
| KS8 | Career management skills |
| KS9 | Learning to learn (managing personal and professional development, self-management) |
| KS10 | Numeracy |

| At the end of this module, students will be able to | | Key Skills | |
|---|---|---|---|
| 1 | Understand and calculate the magnitude of loads and stresses applied to pin jointed structures and beams under static conditions. | KS1 | |
| | | KS4 | |
| | | KS10 | |
| 2 | Understand and calculate the magnitude of loads and stresses applied to rotating components such as shafts and flywheels when subjected to dynamic loading conditions. | KS1 | |
| | | KS4 | |
| | | KS10 | |
| 3 | Explain the properties of fluids, their effect on fluid flow and the importance of their effects on objects in contact with flowing fluids. | KS3 | |
| | | KS4 | |
| | | KS10 | |
| 4 | To explain the laws of thermodynamics, and do calculations to determine heat transfer, the state changes of a liquid and the Coefficient of Performance of a Heat pump. | KS1 | |
| | | KS2 | |
| | | KS3 | |
| | | KS7 | |

| **Derogations** |
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| A derogation from regulations has been approved for this programme which means that whilst the pass mark is 40% overall, each element of assessment (where there is more than one assessment) requires a minimum mark of 30%. |

**Assessment:**

Assessment 1: is by means of a time-constrained test covering outcomes 1 and 2.

Assessment 2: Is based on two practical experiments conducted in the engineering laboratories on subjects such as Fluid dynamics, Thermodynamics or Structures.

The practical assessment shall involve: A fluid dynamics experiment using a Venturi-meter apparatus and a thermodynamics experiment using a Heat Pump apparatus.

| Assessment number | Learning Outcomes to be met | Type of assessment | Weighting (%) | Duration (if exam) | Word count (or equivalent if appropriate) |
|---|---|---|---|---|---|
| 1 | 1,2 | In-class test | 50 | 90 mins. | |
| 2 | 3,4 | Practical | 50 | | 2000 |

**Learning and Teaching Strategies:**

The module will be taught with lectures, tutorials and laboratory sessions.

**Syllabus outline:**

**Solid Mechanics**

**Systems of Force and Moments:** Type of forces; Equilibrium and free-body diagrams; Two dimensional and three-dimensional force systems; Two-dimensional description of moment and moment vector; Couples; Moment of a force about a line; Equivalent systems.

**Structures in Equilibrium:** Trusses; The method of joints; The method of sections; Space Trusses; Frame and machines.

**Direct Stress, Direct Strain and Shear Stress**: Direct stress and direct strain; Young's Modulus of Elasticity; Shear stress; Modulus of Rigidity.

**Compound Bars:** Definition of a compound bar; Stresses and deformation due to uni-axial loads at uniform temperature.

**Shear Force and Bending Moment Diagrams:** Shear force and bending moment diagrams for simply supported and cantilever beams subjected to different loading conditions.

**Simple Bending Theory:** Centroid, first moment of area and second moment of area; Simple bending equation; Application to rectangular, circular and idealised I-section beams; Section modulus; Selection of appropriate beams for given loading using standard section handbooks.

**Simple Torsion Theory:** Simple torsion equation; Relationship between torque and power; Solve problems involving torsion in solid shafts.

**Angular Motion:** Equations for angular motion with constant angular acceleration; Application to practical engineering problems; Relationship between applied torque, angular acceleration and moment of inertia; Radius of gyration; Angular acceleration of discs and flywheels; Static and dynamic balancing; Solution of problems involving out of balance forces by analytical and graphical means.

**Linear and Angular Kinetic Energy:** Expressions for linear and angular kinetic energy; Problems including flywheels and lift systems. Vibrations: Simple harmonic motion; Simple pendulums and spring mass systems; Concept of resonance and resulting problems.

**Material Classification:** isotropic, orthotropic, anisotropic. Poisson's ratio. Two dimensional problems. Volumetric strain. Bulk modulus. Elastic constants.

**Theorem of Parallel Axes:** Second moment of area about the neutral axis for common sections.

**Fluid Mechanics**

**Fluid Properties**: Absolute density, Relative Density, Absolute (Dynamic) viscosity and Kinematic viscosity of liquids and gases, Bulk Modulus, Surface tension. Basic definition and uses of Newton, Reynolds, Froude, Weber and Mach Numbers.

**Fluid Flow**: Laminar, Transitional and Turbulent flow regimes. Boundary Layer, Continuity of Flow and Bernoulli's Equation, Flow through a Venturi-meter.

**Thermodynamics**

**Temperature measurement**: Celsius (Centigrade), Kelvin, Fahrenheit and Rankine scales and Methods of Temperature Measurement.

**Pressure measurement**: Absolute and gauge pressure measurement. Boyle's Law, Charles' Laws and the equation of state for an ideal gas.

**Heat & Work**: Thermodynamic laws, Enthalpy and Entropy, Material Phase Changes, Polytropic processes, the Carnot Cycle, Specific Heat Capacity, Heat Transfer, Vapour-cycle Refrigeration and Heat Pumps.

**Bibliography:**

**Essential reading**

Bolton, W. (2006) Mechanical Science, 3rd Edn. Blackwell Publishing.

**Other indicative reading**

Hannah,J & Hillier,J (1999) Mechanical Engineering Science, 3rd Edn. Prentice Hall.