# Subject Description Form

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| **Subject Code** | ME558 |
| **Subject Title** | Advanced Materials and Structural Design |
| **Credit Value** | 3 |
| **Level** | 5 |
| **Pre-requisite/ Co-requisite/ Exclusion** | Students should have basic knowledge in Mathematics, Engineering Materials, and Solid Mechanics.<br>Exclusion: ME550 Materials and Smart Structural Design |
| **Objectives** | To provide students with knowledge of the mechanical behaviour, manufacturing process and utilizations of advanced composite materials, smart materials and structures, and nano-materials for product design and development with a special emphasize on aircraft applications. |
| **Intended Learning Outcomes** | Upon completion of the subject, students will be able to:<br>a. understand the mechanics of advanced composite materials, especially the mechanics of a lamina and laminates, including failure mechanisms;<br>b. possess the state-of-the-art knowledge on smart materials and smart structure design;<br>c. recognize the importance of nano-materials in advanced technology; and<br>d. understand the application of advanced composites, smart materials, smart structures, and nano-materials in aircraft design. |
| **Subject Synopsis/ Indicative Syllabus** | ***Advanced Composite Materials:*** Composite constituents; principles of fibre-reinforced composites; mechanics of a lamina; mechanics of laminates, tooling and manufacturing processes; failure criteria for composites; aircraft applications and related design issues.<br>***Piezoelectric Materials:*** The fundamental mechanisms of piezoelectric materials and major applications, Curie temperature, concept of piezoelectric moduli and applications of these moduli in design of sensors and actuators, smart structure design issues.<br>***Shape Memory Alloys (SMA):*** Phenomena & mechanisms of temperature controlled shape memory effect, critical temperatures, stress effect on critical temperatures, mechanical properties of SMA at different phases and temperatures, shape memory and superelasticity, modeling of the effects of temperature and stress, special design considerations at joints, continuum vs. discrete applications of SMA, major impediments to applications of SMA.<br>***Nanomaterials:*** Nano-materials for product design; mechanical and thermal properties of nano-composite materials.<br>***Smart Structures:*** Introduction to smart structures; fibre-optic sensors; integrated sensing, controlling and actuating techniques. Selected applications of smart structures in aircraft design.<br>***Laboratory Works:***<br>• Mechanical properties of shape memory alloys.<br>• Strain measurement of composite structures using embedded fibre-optic sensors. |
| **Teaching/Learning Methodology** | 1. The teaching and learning methods include lectures/tutorial sessions, homework assignments, test, mini-project or case study and examination.<br>2. The continuous assessment and examination are aimed at providing students with integrated knowledge required for advanced materials and structural design.<br>3. Technical/practical examples and problems are raised and discussed in class/tutorial sessions. |

| Teaching/Learning Methodology | Intended subject learning outcomes | | | |
|---|---|---|---|---|
| | a | b | c | d |
| 1. Lecture | √ | √ | √ | √ |
| 2. Tutorial | √ | √ | √ | √ |
| 3. Homework assignment | √ | √ | | √ |
| 4. Mini-project/Case study report and presentation | | √ | √ | √ |

**Assessment Methods in Alignment with Intended Learning Outcomes**

| Specific assessment methods/tasks | % weighting | Intended subject learning outcomes to be assessed | | | |
|---|---|---|---|---|---|
| | | a | b | c | d |
| 1. Homework assignment | 20% | √ | √ | | √ |
| 2. Test | 15% | √ | | | |
| 3. Mini-project/Case study report and presentation | 15% | | √ | √ | √ |
| 4. Examination | 50% | √ | √ | √ | √ |
| Total | 100% | | | | |

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Overall Assessment:

$0.50 \times$ End of Subject Examination + $0.50 \times$ Continuous Assessment

The continuous assessment consists of three components: homework assignments, test, mini-project or case study report & presentation. They are aimed at evaluating the progress of students study, assisting them in self-monitoring of fulfilling the respective subject learning outcomes, and enhancing the integration of the knowledge learnt.

The examination is used to assess the knowledge acquired by the students for understanding and analyzing the problems critically and independently; as well as to determine the degree of achieving the subject learning outcomes.

**Student Study Effort Expected**

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| Class contact: | |
| ▪ Lecture | 24 Hrs. |
| ▪ Tutorial/Case Study/Laboratory | 15 Hrs. |
| Other student study effort: | |
| ▪ Self Study | 42 Hrs. |
| ▪ Mini-project/Case study report preparation and presentation | 24 Hrs. |
| Total student study effort | 105 Hrs. |

**Reading List and References**


1. Alan Baker, Stuart Dutton and Donald Kelly, *Composite Materials for Aircraft Structures*, AIAA, latest edition.
2. Ronald F. Gibson, *Principles of Composite Material Mechanics*, McGRAL-HILL, latest edition.
3. Srinivasan A. V. and McFarland D. M., *Smart Structures*, Cambridge University Press, latest edition.
4. Banks H. T., Smith R. C. and Wang Y., *Smart Material Structures*, John Wiley & Sons, latest edition.
5. Nanostructured Materials - Processing, Properties, and Applications, edited by Carl C. Koch, William Andrew Publishing, latest edition.