# Subject Description Form

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| **Subject Code** | ME557 |
| **Subject Title** | CFD and Thermofluid System Design |
| **Credit Value** | 3 |
| **Level** | 5 |
| **Pre-requisite/ Co-requisite/ Exclusion** | Students should have basic knowledge in Thermofluids<br><br>Exclusion: ME549 Computational Fluid Dynamics and Its Applications |
| **Objectives** | To provide students with knowledge of computational fluid dynamics and numerical heat transfer; to make the students have the ability to model and solve the practical problems in industry. |
| **Intended Learning Outcomes** | Upon completion of the subject, students will be able to:<br>a. possess state-of-the-art knowledge and skills in the area of computational fluid dynamics and numerical heat transfer, be able to apply their knowledge and skills in designing and developing products or engineering systems;<br>b. think critically and holistically in dealing with real CFD problems, and generate practical solutions; and<br>c. recognize the need for, and engage in life-long learning. |
| **Subject Synopsis/ Indicative Syllabus** | ***Introduction to Numerical Methods:*** Governing equations of fluid flow and heat transfer; finite element method; finite difference method; finite volume method; lattice Boltzmann method and other numerical techniques.<br>***Numerical Techniques:*** Steady and unsteady solution; influence of relaxation factors; stability and convergence; explicit and implicit methods.<br>***Boundary Conditions:*** Boundary conditions for internal flow; boundary conditions for external flow; boundary conditions for thermal problem.<br>***Mesh Generation:*** Types of the mesh; 2D mesh; 3D mesh; mesh refinement and optimization; mesh generation using software.<br>***Viscous Models:*** Laminar model; inviscid model; Spalart-Allmaras model (1 equation); k-epsilon model (2 equations); Reynolds stress model; Large Eddy Simulation model.<br>***Case Study – Fan and Impeller Design***: Airfoil and cascade; impeller simulation; vorticity analysis; fan efficient analysis.<br>***Case Study – Thermal Management of Electronic Equipment:*** Conjugated heat transfer in electronic package design; cooling electronic equipment by natural convection; optimum heat transfer; flow around cylinders.<br>***Case Study – Room Ventilation Design:*** Diffuser design; diffuser arrangement design; air quality evaluation. |
| **Teaching/Learning Methodology** | 1. The teaching and learning methods include lectures/tutorial sessions, homework assignments, test, case study report and examination.<br>2. The continuous assessment and examination are aimed at providing students with integrated knowledge required for CFD and thermofluid system 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 |
| 1. Lecture | √ | √ | √ |
| 2. Tutorial | √ | √ | √ |
| 3. Homework assignment | √ | √ | √ |
| 4. Case study report and presentation | √ | √ | √ |

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<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="3">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td></tr>
<tr><td>1. Homework assignment</td><td>20%</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>2. Test</td><td>20%</td><td>√</td><td>√</td><td></td></tr>
<tr><td>3. Case study report and Presentation</td><td>20%</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>4. Examination</td><td>40%</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Total</td><td>100%</td><td colspan="3"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:<br><br>
Overall Assessment:<br><br>
$0.40 \times$ End of Subject Examination + $0.60 \times$ Continuous Assessment<br><br>
The continuous assessment consists of three components: homework assignments, test, and 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.<br><br>
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.
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<tr><td>Student Study Effort Expected</td><td>
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<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>21 Hrs.</td></tr>
<tr><td>▪ Tutorial/Case study</td><td>18 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Self Study</td><td>45 Hrs.</td></tr>
<tr><td>▪ Case study report preparation and presentation</td><td>21 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>105 Hrs.</td></tr>
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<tr><td>Reading List and References</td><td>
1. Fletcher C. A. J., Computational Techniques for Fluid Dynamics: A Solutions Manual, Springer-Verlag, latest edition.<br>
2. Reddy J. N. and Gartling D. K., The Finite Element Method in Heat Transfer and Fluid Dynamics, Boca Raton, Fla., CRC Press, latest edition.<br>
3. Anderson J. D., Computational Fluid Dynamics, McGraw-Hill, latest edition.<br>
4. Versteeg H. K. & Malalasekera W., An Introduction to Computational Fluid Dynamics, Longman, latest edition.<br>
5. Rao, S. S., The finite element method in engineering, Pergamon Press, latest edition.<br>
6. Shaw C. T., Using Computational Fluid Dynamics, Prentice Hall, latest edition.
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