Subject Description Form

Subject Code	ME6102
Subject Title	Advanced Topics in Control, Acoustics, and Dynamics
Credit Value	3
Level	6
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	1. To equip students with the knowledge of advanced control and learning systems. 2. To equip students with the knowledge of advanced acoustics. 3. To equip students with the knowledge of advanced wave theory.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) Synthesise feedback control methods for automating various systems and machines. b) Design computing algorithms for learning models and recognising patterns in signals. c) Model acoustic wave generation, propagation, reflection, scattering and absorption in various media. d) Apply the conceptual and theoretical acoustics knowledge to analyse acoustical problems. e) Apply the wave propagation theory to simulation, analyse and solve problems of wave propagation. f) Design non-destructive evaluation approaches using guided waves.
Subject Synopsis/ Indicative Syllabus	**Module 1. Control and Learning Systems**. • **Systems Modelling.** Discrete/continuous-time systems; Linear/non-linear systems; Energy-based dynamics; Differential kinematic systems. • **Control Systems.** Feedback signals; Lyapunov stability; LQ-based control; Model-based nonlinear control; Adaptive sensor servoing; • **Learning Systems.** Connectionist models; Backpropagation; Recurrent NN; Reinforcement learning; Hebbian learning; Self-organising maps. **Module 2. Advanced Acoustics** • **Fluid Acoustics.** Dynamics of fluid motion; Acoustic wave motion; Acoustics in moving media; Green's function; Internal energy loss. • **Acoustical System Coupling.** Systems of infinite extent; Finite panel; Periodically supported systems; Coupled cavities. • **Non-linear Acoustics.** Non-linear steepening; Harmonic equation of acoustic waves; Weak-shock theory; Anomalous energy dissipation. **Module 3. Elastic Wave Propagation in Solids: Linear and Nonlinear Aspects**

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- **Fundamental Theory.** Dispersion; Waves in layered plates and hollow cylinders; waves in viscoelastic medium.
- **Modelling Waves.** Analytical solutions; semi-analytical finite element method; modeling wave propagation.
- **Nonlinear Method.** Bulk waves in weakly nonlinear elastic medium; second harmonic generation; Weakly nonlinear wave equation.
- **Study Extension**. Phased array; imaging.

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<tr><td>Teaching/Learning Methodology</td><td>Lectures and Tutorials</td></tr>
<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="6">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td></tr>
<tr><td>1. Continuous Assessment</td><td>50%</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td></tr>
<tr><td>2. Examination</td><td>50%</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td><td>✔</td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="6"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:
1. The assessment is comprised of 50% continuous assessment and 50% examination.
2. The continuous assessment aims 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.
3. 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>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>33 Hrs.</td></tr>
<tr><td>▪ Tutorials</td><td>6 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Assignments</td><td>28 Hrs.</td></tr>
<tr><td>▪ Self-learning</td><td>39 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>106 Hrs.</td></tr>
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Reading List and References	1. Lecture Notes 2. Darryl D. Holm, Geometric Mechanics and Symmetry From Finite to Infinite Dimensions, Latest Edition 3. Jean-Jaques Slotine, Applied Nonlinear Control, First Edition 4. Simon Haykin, Neural Networks and Learning Machines, Latest Edition 5. Philip Morse, Uno Ingard, Theoretical Acoustics, Latest Edition 6. Fabien Anselmet, Pierre-Olivier Mattei, Acoustics, Aeroacoustics and Vibrations, Latest Edition 7. Joseph Rose, Ultrasonic Guided Waves in Solid Media, Cambridge University Press, Latest Edition

(Implemented from 2019/20 academic year.)

March 2019