Subject Description Form

Subject Code	ME46001
Subject Title	Numerical Predictive Product Analysis
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisite: ME31003 System Dynamics
Objectives	To equip students with necessary knowledge in numerical and computer-aided predictive analysis tools so that they can effectively contribute in enhancing the quality and performance of products.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Apply knowledge of mathematics and engineering sciences via analytical and computational approaches to analyze and predict the performance of a product. b. Use related software tools to perform mathematical analysis effectively. c. Select and use appropriate computer-aided analysis techniques to predict performance of a product and optimize its functions, resource usage, environmental performance, etc. d. Formulate, execute and systematically manage a product analysis project using limited resources and communicate the project outcomes effectively.
Subject Synopsis/ Indicative Syllabus	***Introduction to Numerical Methods for Product Analysis*** – Mathematical modeling of engineering problems. Taylor's theorem with remainders. Series expansion for elementary functions. Major sources of errors involved in numerical methods. Use of software tools for numerical analysis: MATLAB fundamentals, programming with MATLAB. ***Optimization*** - Introduction to optimization. Development of objective functions and associated constraints and variables. Constrained optimization: Linear and non-linear programming problems. Case studies using MATLAB. ***Curve Fitting and Regression*** – Introduction to curve fitting, interpolation and extrapolation. Linear regression and non-linear regression. Use of software tools (MATLAB and Excel) to solve related problems. ***Computer-aided Predictive Analysis*** - Motion simulation, drop test, fatigue analysis, frequency analysis, computational flow dynamics analysis, thermal analysis, environmental performance analysis, optimization studies.

Teaching/Learning Methodology

1. Students will develop the intended learning outcomes mainly by undertaking a design analysis group project using CAE technologies and mathematical analysis software tools. Design analysis will be done for a new product developed by the students or for a selected existing product. The product should consist of several components made of different materials and some moving link mechanisms (example products: Lock pliers, garden scissors, stapler machine, bearing puller, children's toy, link mechanisms in machinery, linkage driven exercising units, etc.)
2. The lectures are aimed at providing students with necessary background knowledge in related mathematical principles, and computer-aided tools for product analysis. (Outcomes a to c)
3. The tutorials are aimed at enhancing the students' skills in effectively using computer-aided tools for product analysis and to provide them with guidance & timely feedback for mini-project activities. (Outcomes a to c)
4. The mini-project is aimed at providing them with an opportunity to apply the knowledge acquired from the course to solve real world product analysis problems. It is also expected that the students will enhance their team-working skills, written and oral communication skills by effectively participating in project learning and assessment activities. (Outcomes a to d)
5. The assignments are to get students engaged with learning activities continuously and to provide them with self-assessment opportunities on their progress of learning. (Outcomes a to c)

Teaching/Learning Methodology	Outcomes			
	a	b	c	d
Lecture/Tutorial	√	√	√	
Mini-project report & presentation	√	√	√	√
Homework assignments/ In-class exercises	√	√	√	

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 assignments/ In-class exercises	10%	√	√	√	
2. Test	15%	√	√	√	
3. Mini-project report & presentation	25%	√	√	√	√
4. End-of-semester Examination	50%	√	√	√	
Total	100%				

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

Overall Assessment: 0.5 × Continuous Assessment + 0.5 x Examination.

	1. Homework assignments & in-class exercises are aimed at evaluating the progress of students study and assisting them in fulfilling the respective subject learning outcomes. 2. Test and examination will be used to assess the degree of achieving the subject learning outcomes by individual student. Their understanding of mathematical and design principles and ability to apply them to critically analyze related problems will be tested. 3. The mini-project is to assess students learning outcomes while providing them with opportunities to apply their learnt knowledge, enhance written & oral communication skills and team-working spirit.	
Student Study Effort Expected	Class contact:	
	▪ Lectures	26 Hrs.
	▪ Tutorials/Mini-project discussions & presentation	13 Hrs.
	Other student study effort:	
	▪ Self study/assignments	39 Hrs.
	▪ Mini-project report preparation and presentation	39 Hrs.
	Total student study effort	117 Hrs.
Reading List and References	1. S.C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill, latest edition 2. S.C. Chapra and R.R. Canale, Numerical Methods for Engineers, McGraw-Hill, latest edition 3. S.S. Rao, applied Numerical Methods for Engineers and Scientists, Prentice-Hall, latest edition 4. Robert L. Norton, Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, McGraw-Hill, latest edition	

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