The Hong Kong University of Science and Technology
UG Course Syllabus

[Course Title]:	Statics and Dynamics
[Course Code]:	MECH2020
[No. of Credits]:	3
[Any pre-/co-requisites]:	(MATH 1012 (prior to 2025-26) OR MATH 1013 OR MATH 1020 OR MATH 1023) AND (PHYS 1111 OR PHYS 1112 OR PHYS 1312)
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Course Description

This course introduces the fundamental principles of statics and dynamics for analysing the equilibrium and motion of mechanical systems. As a required course for the BEng in Mechanical Engineering and Aerospace Engineering, as well as an officially designated Blended Learning course since 2025, it equips students with essential analytical skills through a combination of theoretical foundations, problem-solving techniques, and interactive learning activities.

The course begins with statics, covering the equilibrium of particles and rigid bodies in two and three dimensions. Students learn to construct free-body diagrams, analyse distributed forces, determine equivalent force systems, and solve problems involving the equilibrium of rigid bodies. These concepts are extended to the analysis of engineering structures, including trusses, frames, and machines, as well as advanced mechanical systems.

The second part of the course addresses particle dynamics. Topics include kinematics of particles (rectilinear and curvilinear motion, path and polar coordinates), followed by kinetics using Newton's second law, equations of motion, and kinetic diagrams. Emphasis is placed on relating forces, mass, and acceleration, with applications of energy methods where appropriate.

The course is delivered through a blended format with flipped classroom that integrates interactive discussion via lectures, tutorials, and online videos with fundamental concepts explanations. Students will complete assignments and engage in problem-solving exercises to develop their ability to model mechanical systems, apply equilibrium and motion equations, and interpret results. By the end of the course, students will be able to analyze both static and dynamic problems with clarity and engineering judgment.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Apply the fundamental principles of equilibrium to analyse particles and rigid bodies in two- and three-dimensional systems.
2. Determine and evaluate engineering structures, including trusses, frames, and machines, using static equilibrium methods.
3. Describe and analyse the motion of particles using kinematic concepts, coordinate systems, and related equations.
4. Evaluate the kinetics of particles and apply Newton's second law, equations of motion, and energy methods to simple mechanical systems.

Assessment and Grading

This course will be assessed using criterion-referencing. Grades will not be assigned using a curve. The overall performance will be determined according to students' achievement of the intended learning outcomes via assignments, quizzes, and a final examination. Details of the assessments' tools are shown below:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Online-videos' questions	N/A (practice only)	Throughout the term
Assignments	20%	Throughout the term
Quizzes	30%	Weeks 5, 9 and 13
Final examination	50%	Final examination period

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Assignments	ILO1, ILO2, ILO3, ILO4	Homework assignments assess students' ability to apply the theoretical and analytical tools introduced in lectures and tutorials as well as online videos. Through structured problem sets, students apply equilibrium principles to particles and rigid bodies in two- and three-dimensional systems (ILO 1), analyse and evaluate engineering structures such as trusses, frames, and machines (ILO 2), describe and analyse particle motion using kinematic concepts and coordinate systems (ILO 3), and evaluate the kinetics of particles by applying Newton's second law, equations of motion, and energy methods (ILO 4).
Quizzes	ILO1, ILO2, ILO3, ILO4	Quizzes assess students' understanding in a progressive and step-by-step manner throughout the course. Each quiz focuses on specific topics and ILOs, allowing students to build foundational knowledge incrementally. Early quizzes emphasize equilibrium analysis of particles and rigid bodies (ILO 1) and structural analysis (ILO 2), while later quizzes assess kinematics of particles (ILO 3) and kinetics using Newton's laws and energy methods (ILO 4). This approach helps students consolidate concepts gradually and prepares them for integrated problem-solving in the final examination.
Final examination	ILO1, ILO2, ILO3, ILO4	The final examination is cumulative and assesses individual achievement of the core conceptual and analytical learning outcomes of the course. Students are required to apply equilibrium principles to particles and rigid bodies (ILO 1), analyse structures such as trusses, frames, and machines (ILO 2), describe and solve particle kinematics problems using different coordinate systems (ILO 3), and solve kinetics problems involving Newton's second law and energy methods (ILO 4).

Grading Rubrics

Details of the grading rubrics are shown as follows:

Rubrics for assignments:

Criteria	Excellent	Good	Satisfactory	Marginal	Fail	Map to Course ILOs
Conceptual understanding	Demonstrates clear and accurate understanding of equilibrium, kinematics, and kinetics concepts. Correctly explains assumptions and limitations of methods used.	Shows good understanding with only minor omissions or imprecision.	Shows adequate understanding of basic concepts but may lack depth.	Shows limited understanding; explanations are incomplete or partially incorrect.	Shows little or no understanding of the relevant concepts.	ILO 1, 2, 3, 4
Application of theory	Correctly selects and applies appropriate statics and dynamics theories (e.g., equilibrium equations, free-body diagrams, Newton's laws, energy methods).	Applies appropriate methods with mostly correct reasoning and minor errors.	Applies standard methods to familiar problems but may contain some procedural errors.	Attempts to apply methods but with significant errors or weak justification.	Fails to apply appropriate methods or uses irrelevant approaches.	ILO 1, 2, 3, 4
Mathematical accuracy	Solutions are mathematically sound, logically organized, and lead to correct results with proper units and notation.	Solutions are generally correct with only minor algebraic or numerical errors.	Solutions show reasonable effort but include some significant errors.	Solutions are incomplete or contain major mathematical errors.	Solutions are largely absent, incorrect, or not submitted.	ILO 1, 2, 3, 4
Physical interpretation	Provides clear interpretation of results, including equations, diagrams, and engineering significance.	Provides reasonable interpretation, though some details may be missing.	Provides basic interpretation but may not fully connect results to physical behaviour.	Provides limited or superficial interpretation.	Provides no meaningful interpretation of results.	ILO 1, 2, 3, 4

Rubrics for quizzes:

Criteria	Excellent	Good	Satisfactory	Marginal	Fail	Map to Course ILOs
Conceptual accuracy	Demonstrates accurate and thorough understanding of the specific topic tested.	Shows good understanding with minor gaps.	Shows adequate understanding of core concepts.	Shows limited understanding with noticeable misconceptions.	Demonstrates little or no understanding of the topic.	ILO 1, 2, 3, 4
Problem-solving approach	Applies correct methods and logical steps to solve problems efficiently.	Uses appropriate methods with mostly correct steps and minor mistakes.	Applies standard procedures but may lack clarity in reasoning.	Shows inconsistent or flawed problem-solving approach.	Fails to demonstrate a valid problem-solving approach.	ILO 1, 2, 3, 4
Calculation correctness	All calculations are correct, well-organized, and properly presented.	Most calculations are correct with only minor errors.	Calculations show partial correctness with some significant errors.	Calculations contain major errors or are incomplete.	Calculations are largely incorrect or missing.	ILO 1, 2, 3, 4
Clarity and organization	Answers are clearly written, well-organized, and easy to follow.	Answers are mostly clear and organized.	Answers are understandable but may lack structure.	Answers are disorganized or difficult to follow.	Answers are incoherent or illegible.	ILO 1, 2, 3, 4

Rubric for Final Examination

Criteria	Excellent	Good	Satisfactory	Marginal	Fail	Map to Course ILOs
Equilibrium analysis (Particles & Rigid Bodies)	Correctly and independently applies equilibrium principles to particles and rigid bodies in 2D and 3D systems.	Applies equilibrium methods mostly correctly with minor errors.	Applies equilibrium analysis to familiar problems but with some errors.	Shows limited ability to apply equilibrium principles.	Fails to apply basic equilibrium tools.	ILO 1
Structural analysis	Clearly analyses trusses, frames, and machines using appropriate methods (e.g., method of joints/sections).	Provides good analysis of structures with minor errors or omissions.	Provides adequate analysis but may lack depth or contain errors.	Shows limited understanding of structural analysis.	Fails to analyse structures meaningfully.	ILO 2
Kinematics of particles	Accurately describes and analyses particle motion using rectilinear, curvilinear, path, and polar coordinates.	Analyses kinematics with mostly correct reasoning and minor errors.	Demonstrates adequate understanding of basic kinematic concepts.	Shows limited ability to analyse particle motion.	Fails to apply kinematic concepts correctly.	ILO 3
Kinetics of particles	Correctly applies Newton's second law, equations of motion, kinetic diagrams, and energy methods to solve dynamics problems.	Applies kinetics methods mostly correctly with minor errors.	Demonstrates adequate understanding of kinetics but may struggle with complex problems.	Shows limited or fragmented understanding of kinetics.	Fails to apply kinetics principles at an acceptable level.	ILO 4
Mathematical accuracy, organization, and clarity	Work is accurate, logically structured, clearly presented, and uses appropriate equations, units, and notation under exam conditions.	Work is generally clear and accurate with minor errors.	Work is understandable but may contain errors or lack organization.	Work is poorly organized or contains major errors.	Work is incoherent, largely incorrect, or missing.	ILO 1, 2, 3, 4

Final Grade Descriptors

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates an excellent command of the fundamental principles of statics and dynamics. Applies equilibrium principles accurately and insightfully to analyse particles and rigid bodies in two- and three-dimensional systems. Clearly analyses and evaluates engineering structures such as trusses, frames, and machines. Provides a strong and physically grounded analysis of particle kinematics using appropriate coordinate systems. Evaluates particle kinetics with confidence using Newton's second law, equations of motion, kinetic diagrams, and energy methods. Work is accurate, well organized, and shows strong physical insight and engineering judgment.
B	Good Performance	Demonstrates good understanding of the main concepts in statics and dynamics. Applies most equilibrium methods correctly to particles and rigid bodies and shows good ability to analyse structures, particle kinematics, and kinetics. Solves standard and moderately challenging problems with generally sound reasoning. Homework and quiz submissions are clear and technically competent, with only minor weaknesses in depth, precision, or completeness.
C	Satisfactory Performance	Demonstrates adequate understanding of core statics and dynamics concepts and can apply standard methods to familiar problems. Shows satisfactory ability to analyse equilibrium of particles and rigid bodies, evaluate structures, describe particle motion, and apply basic kinetics principles. Some errors or gaps in reasoning may be present, and physical interpretation may lack depth, but the main learning outcomes are achieved at an acceptable level.
D	Marginal Pass	Demonstrates threshold understanding of basic statics and dynamics concepts but has difficulty applying theories consistently or accurately. Can attempt standard calculations involving equilibrium, structural analysis, kinematics, and kinetics, but work may contain significant errors, incomplete reasoning, or weak physical interpretation. There is sufficient evidence of partial achievement of the course learning outcomes, but performance is limited.
F	Fail	Demonstrates insufficient understanding of fundamental statics and dynamics concepts. Is unable to apply basic equilibrium principles to particles and rigid bodies, fails to analyse structures meaningfully, cannot properly describe particle kinematics, or cannot evaluate kinetics at an acceptable level. Work contains major conceptual and mathematical errors, is incomplete, or does not demonstrate achievement of the intended learning outcomes.

Course AI Policy

The use of artificial intelligence (AI) tools is permitted in this course for learning support, brainstorming, checking understanding, improving accuracy of calculations, and assisting with problem-solving, etc. However, students remain fully responsible for the accuracy, originality, and integrity of all submitted work.

For homework assignments, students may use AI tools to support their learning. However, all homework assignments must be handwritten, either on physical paper or using an electronic device such as a tablet with a stylus. Typed or AI-generated solutions will not be accepted. Students are encouraged to use AI as a learning aid but must ensure that the final submitted work reflects their own understanding and reasoning.

The use of AI tools is not permitted during quizzes and the final examination, as these assessments are conducted face-to-face under invigilated conditions. Any attempt to use AI tools or unauthorized assistance during quizzes or the final examination will be considered a violation of academic integrity.

Communication and Feedback

Assessment marks for individual assessed tasks will normally be communicated via Canvas within two weeks of submission. Feedback may include written comments, annotated solutions, marking rubrics, sample solutions, in-class or tutorial discussion, or verbal feedback during tutorial sessions.

Homework feedback will focus on the correctness of methods, mathematical execution, physical interpretation of results, etc. Quiz feedback will emphasize conceptual understanding, problem-solving approach, and identification of common errors to support progressive learning. Final examination feedback will be provided in the form of general comments on overall performance and common mistakes, along with sample solutions where appropriate.

Students who have questions about feedback or marks should contact either the instructor or teaching team within two weeks after the feedback is released.

Resubmission Policy

To ensure fairness to students who submit work on time, late submissions for assignments or other materials needed will be subject to **a penalty of 20% of the attained mark per day**, unless prior approval has been granted by the instructor or valid supporting documentation is provided.

Required Texts and Materials

Recommended textbooks for this course are:

- Vector Mechanics for Engineers Statics SI, latest version (Beer, Johnston and Mazurek – McGraw Hill)
- Vector Mechanics for Engineers Dynamics SI, latest version (Beer, Johnston and Cornwell – McGraw Hill)
- Lecture and online materials provided by the Instructor
- Engineering Statics and Dynamics related textbooks/materials available at the HKUST library

Academic Integrity

Students are expected to adhere to the university's academic integrity policy and to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Students should refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.