Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY2026-2027
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Professor Raju V. Ramanujan
Course Author Email	ramanujan@ntu.edu.sg
Course Title	Advanced Metallic Materials
Course Code	MS6011
Academic Units	3
Contact Hours	39
Research Experience Components	

Course Requisites (if applicable)

Pre-requisites	
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

The aim of this course is to understand advanced metallic materials and their applications employing a materials science and engineering framework based on processing-structure-property-performance relationships.

At the end of this course, you will:

1. Obtain an understanding of metallic materials and their role in modern technological applications.
2. Apply a design led approach to metallic materials.
3. Critically analyse and construct case studies in metallic materials.

The course will be useful to students who are interested in understanding metals from a materials perspective. This course will prepare you for placement with companies engaged in development of metals, systems, and devices or to continue higher postgraduate studies.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Describe the various types of metallic materials and their properties.
ILO 2	Deploy the structure-property-processing-performance paradigm.
ILO 3	Identify metallic materials for stiffness, fracture, creep, strength limited applications.
ILO 4	Apply manufacturing and sustainability concepts to metals selection.
ILO 5	Construct case studies for speciality steels, titanium alloys and superalloys.

Course Content

1. Introduction: metals — history, classification, and properties

a. Materials property charts
b. Exercises

2. Metals, processes, and design

a. Design process
b. Materials selection
c. Exercises

3. Metals properties and microstructure

a. Materials properties and length scales
b. Exercises

4. Stiffness limited applications

a. Materials selection for stiffness
b. Exercises

5. Strength limited applications

a. Strength and ductility based metals selection
b. Exercises

6. Fracture limited applications

a. Materials selection for fracture resistance
b. Exercises

7. High temp. metals

a. Design for creep
b. Exercises

8. Wear, Corrosion, Friction

a. Materials for friction related design
b. Exercises

9. Functional Properties

a. Electric, magnetic based design
b. Exercises

10. Manufacturing

    a. Processing for properties
    b. Heat treatment
    c. Joining
    d. Exercises

11. Sustainability

    a. Metals production, consumption, and growth
    b. Metals and eco-design
    c. Metals and sustainable development

12. Case studies

    a. Maraging steel
    b. High strength low alloy steel
    c. Superalloys
    d. Titanium alloys
    e. Intermetallics

Reading and References (if applicable)

Introduction to MSE- a design led approach, M.F. Ashby et al, Elsevier (2023).

Modern physical metallurgy, R.E. Smallman and AHW Ngan, 8th Edn., Elsevier (2014).

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Introduction: metals — history, classification, and properties; Metals, processes, and design	1	Lecture notes	Online	Pre-recorded Lecture
2	Metals properties and microstructure; Stiffness limited applications	2,3	Lecture notes	Online	Pre-recorded Lecture
3	Strength Limited applications; Fracture limited application	3	Lecture notes	Online	Pre-recorded Lecture
4	High temperature metals; Wear, Friction, corrosion	3	Lecture notes	Online	Pre-recorded Lecture
5	CA1: Online MCQ Quiz	1,2,3	N/A	Online	CA1: Online MCQ Quiz
6	Functional properties, Manufacturing, Sustainability	4	Lecture notes	Online	Pre-recorded Lecture
7	Case Studies 1 & 2	5	Lecture notes	Online	Pre-recorded Lecture
8	CA2: Online MCQ Quiz	4,5	N/A	Online	CA2: Online MCQ Quiz
9	CA2: Online MCQ Quiz (live feedback and discussion)	4,5	N/A	Online	CA2: Online MCQ Quiz (live feedback and discussion)

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
10	Case Study 3	5	Lecture notes	Online	Pre-recorded lecture
11	CA3: Online MCQ Quiz	1-5	N/A	Online	CA3: Online MCQ Quiz
12	CA3: Online MCQ Quiz (live feedback and discussion)	1-5	N/A	Online	CA3: Online MCQ Quiz (live feedback and discussion)
13	Recap and open dialogue discussion of future trends	1-5	N/A	Online	Recap and open dialogue

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Online lectures	Online lectures hosted by the Adaptive Teaching and Learning Applications System (ATLAS) will accelerate learning.
Online assessment	Three continuous assessments will be conducted on-line through the semester.
Demonstrations and Prerecorded lectures by guest speakers	The lectures by guest speakers will provide valuable insight into topics of current interest.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Test/Quiz(CA1: Online MCQ quiz)	1,2,3		30		Individual	Holistic	Multistructural
2	Continuous Assessment (CA): Test/Quiz(CA2: Online MCQ quiz)	4-5		30		Individual	Holistic	Relational
3	Continuous Assessment (CA): Test/Quiz(CA3: Online MCQ quiz)	1-5		40		Individual	Holistic	Multistructural

Description of Assessment Components (if applicable)

CA1: Individual online MCQ quiz

CA2: Individual online MCQ quiz

CA3: Individual online MCQ quiz

Formative Feedback

You will receive formative feedback for CA2 and CA3 after submission. Time has been allotted for the feedback.

You can proactively approach me or the TA regarding the tutorial questions and solutions.

You will receive summative group feedback on your performance following the conclusion of the course.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Collaboration	Intermediate
Communication	Advanced
Problem Solving	Advanced
Information Literacy	Advanced
Critical Thinking	Advanced

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all assigned readings, activities, assignments, attend all classes punctually and complete all scheduled assignments by due dates. You are expected to take responsibility to follow up with assignments and course related announcements. You are expected to participate in all project critiques, class discussions and activities.

You should note the schedule of the assessments before the end of the add-drop period and block these timings.

Policy (Absenteeism)

In-class activities make up a significant portion of your course grade. Absence from class without a valid reason will severely affect your grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for in-class activities.

Policy (Others, if applicable)

This graduate course requires a high level of discipline and continuous effort to succeed. You are encouraged to form study groups with your peers and access the many sources of on-line information related to the course content. As the emphasis is on understanding, rather than memorisation, all CAs are open-book and you can use whatever resources will enable you achieve a high grade.

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