

COURSE TEMPLATE

1.	Department centre proposing the course	Applied Mechanics
2.	Course title	Introduction to Materials Science and Engineering
3.	L-T-P structure	3-0-2
4.	Credits	4
5.	Course number	AML 120
6.	Status (category for program)	
7.	Prerequisite	none
8.	Status vis a vis other course	No overlap
9.	Not allowed for (indicate program names)	Allowed for all
10.	Frequency of offering	Every sem
11.	Faculty who will teach the course	Prof. Rajesh Prasad, Dr. Jayant Jain, Dr. Anamika Prasad, Prof. Arvind Agarwal, Dr. Sumantra Mandal
12.	Will the course require any visiting faculty	no
13.	Course objective (50 words)	
	This is an introductory course to teach students basic concepts of structure, property, processing, and performance of wide range of engineering materials. Topics will focus both on the fundamental concepts which cut across engineering disciplines together with real-world applications and future trends in materials. Specifically, engineered alloys, ceramics, polymers, composite materials and electronic and magnetic materials will be discussed. The course will thus provide necessary tools in the understanding of materials science for engineering students.	
14.	Course contents (about 100 words) (Include laboratory/ design activities)	
	<u>The course content covers the following broad topics:</u> Structure of Solids: atomic and inter-atomic bonding, crystal structure and imperfection in solids. Properties of Materials: Mechanical, chemical, electrical and magnetic properties of metals, ceramics and polymers. Processing of Materials: Thermodynamics basics, Phase diagrams and phase transformation of metallic systems, fabrication and processing of metals, polymers and ceramics. Performance of Materials: Creep, fatigue, failure and corrosion of metals, ceramics (including cement and concrete), polymers, and composites (including fiber reinforced structure, sandwich panels, and wood). Selection of Materials: selection of materials for various applications, materials selection charts, CSE software, Example case studies such as materials for large astronomical telescopes, springs, flywheels, safe pressure vessels and reactors. Laboratory: The behavior of different types of materials (e.g. metals, ceramics, composites, polymers) will be studied through carefully designed experiments. The fundamentals of structure and properties of various materials will be communicated through hands on experiments and model demonstration.	

15.	Lecture outline (with topics and number of lectures)	
Module No.	Topic	No. of hours
i)	Introductory lecture	1
ii)	Bonding between atoms: metallic bonding, ionic bonding, covalent bonding, van der waals bond, thermal expansion, elastic modulus and melting point of materials, case study design of telescope mirrors	2
iii)	Miller indices of directions and planes, packing of atoms inside solids, close packed structures, structure of ceramics, ionic solids, glass and polymers, density of various materials	2
iv)	Imperfections in solids: vacancies, equilibrium concentration of vacancies, interstitial and substitutional impurities in solids, dislocations, types and characteristics of dislocations, interfacial defects, stacking faults	2
v)	Yield strength, tensile strength and ductility of materials: stress strain behaviour of metals, ceramics and polymers, tensile test, plastic deformation, necking	3
vi)	Dislocations and yielding in crystals: theoretical strength of perfect crystal, role of dislocations, slip, critical resolved shear criterion, slip systems, twinning	2
vii)	Diffusion in solids: vacancy diffusion, interstitial diffusion, Ficks law of diffusion, diffusion coefficient	1
viii)	Phase transformations: thermodynamics of transformation, equilibrium, Gibbs free energy, diffusional transformations in solids, nucleation and growth, TTT diagrams, heat treatment: annealing, normalising, quenching	3
ix)	Phase diagrams: phases, microstructure, binary phase diagrams: isomorphous system, eutectic system, microstructure development in isomorphous and eutectic systems, lever rule, tie line, Fe-C system, examples of ceramic systems	3
x)	Strengthening methods: grain size strengthening, solid solution strengthening, precipitation hardening, dislocation hardening	2
xi)	Fracture of materials, mechanism of ductile tearing, brittle fracture, Griffiths theory, concept of fracture toughness, ductile to brittle transition	2
xii)	Fatigue behaviour of materials: fatigue curve, fatigue mechanisms, fatigue crack growth rate, examples of fatigue failure: fatigue failures in aircrafts, methods to improve the fatigue life	2
xiii)	Creep behaviour of materials: creep curve, dependence of creep rate on stress, temperature, creep mechanism: dislocation creep, diffusion creep, grain boundary sliding, methods of resisting creep, development of creep resistant turbine blades for jet engines	2
xiv)	Corrosion of materials: electrochemistry of corrosion, driving potential for corrosion, pourbaix diagram, localised attack, galvanic corrosion, effects of environment on corrosion, methods of corrosion prevention	2
xv)	Materials aspect of fabrication of integrated circuit, ferromagnetism and paramagnetism, soft magnetic materials, hard magnetic materials	2
xvi)	Metals: processing and properties of metals: steels, alloy steels, light alloys	2
xvii)	Ceramics: Structure and properties of some important ceramics, cements and concrete	2
xviii)	Polymers: structure, processing and properties of polymers, thermoplastics and thermosetting, glass transition temperature, stress strain behaviour of polymers	2
xix)	Composites: Properties of composite materials, fiber and particulate reinforced composites, sandwich materials, structure and properties of wood	2
xx)	Novel materials such as carbon nanotubes, quasi crystals and nano crystalline materials	1
xxi)	Materials selection case studies: materials selection charts, CSE software, lightest beam, ceramic tiles for space shuttle	2

Course total		42
16.	Brief description of tutorial activities	
N/A		
17.	Brief description of laboratory activities	
Module no.	Experiment description	No. of hours
i)	Study the Bravais lattices and close packed crystal structures	2
ii)	Study the structure of dislocations and grain boundaries in crystalline solids	2
iii)	Experimental study of crystal structure through X-Ray diffraction	3
iv)	Microstructure in some metallic materials through optical microscope	3
v)	Effect of alloying and temperature change on electrical resistivity of a metal	2
vi)	Load-elongation behaviour of rubber and its negative thermal expansion coefficient	2
vii)	Tensile behaviour of metals	2
viii)	Experimental study of deformation characteristics of selected polymers and composites	3
ix)	Fatigue and brittle fracture of metals, identification of surface and internal flaws through non-destructive testing	3
x)	Deformation characteristics of selected ceramics	3
xi)	Experimental study of deformation and recrystallization behaviour of metals	3
	Total	28
18.	Suggested text and reference materials	
	- Michael F Ashby David R H Jones <i>Engineering Materials 1: An Introduction to Properties, Applications and Design</i>, Butterworth Heinemann - Michael F Ashby David R H Jones <i>Engineering Materials 2: An Introduction to Microstructure and Processing</i>, Butterworth Heinemann - William D. Callister, David G. Rethwisch <i>Materials Science and Engineering: An Introduction</i>, Wiley Publishers - V Raghavan <i>Materials Science and Engineering: A First Course</i>, Printice Hall India	
19.	Resources required for the course	
19.1	Software	Teaching softwares such as Cambridge engineering selector (CSE), Carine
19.2	Hardware	Computers to run above softwares
19.3	Teaching aides (videos, etc.)	Models for crystal structure, defects etc
19.4	Equipment	Hardness tester, microscope, tensile tester, NDT tester, furnaces, rolling mill, impact tester etc.
19.5	Class room infrastructure	White board, projection system
19.6	Site visits	Visits to nearby materials intensive industries like Maruti can be planned
20. Design content of the course		
Examples and case studies to be discussed in the course include design elements		

Date:

23/10/2013

Signature of Head of Department