Bachelor of Technology in Mechanical Engineering

Short Syllabus

BMEE304L Metal Forming and Machining (3-0-0-3)

Elastic and Plastic Behavior - stress tensor - flow stress - yield criteria - methods of forming analysis - Bulk Forming of Metals: Forging, Rolling, Extrusion, Drawing – Sheet Metal Forming: FLD, HERF, Electromagnetic forming - Machine Tools and Operations, Mechanics of Metal cutting, Heat Flow in Metal Cutting and Tool Life, Gear generation and Unconventional machining methods.

BMEE304L	Metal Forming and Machining	L	T	P	C
		3	0	0	3
Pre-requisite	**BMEE209L, BMEE209P**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart knowledge on the basic principles of metal forming theories and processes.
2. To give an insight on metal cutting theories, machine tools, and machining processes.

Course Outcomes

At the end of the course, the student will be able to

1. Develop the yield criterion and workability behaviors of materials.
2. Evaluate various bulk and sheet metal forming processes for different functional requirements.
3. Demonstrate various machine tools and machining operations.
4. Analyse the mechanics of metal cutting processes.
5. Investigate the heat flow, tool life and tool wear during metal cutting process.

Module:1	**Fundamentals of Metal Forming**	**6 hours**

Stress-Strain relations in elastic and plastic deformation, stress tensor, yield criteria, yield locus, octahedral shear stress and shear strains, invariants of stress strain, slip line field theory plastic deformations of crystals temperature and strain rate dependence, determination of flow stress- Slab analysis - Upper bound analysis - Slip line field analysis, recrystallization, Deformation zone geometry - Numerical problems.

Module:2	**Bulk Forming of Metals**	**7 hours**

Forging: Classification of forging processes – Forging machines & equipment's – Forging pressure & load in open die forging and closed die forging – Friction hill – Die-design parameters – Metal flowlines in forging – Forging defects – Residual stresses in forging - Powder metallurgy forging.

Rolling: Classification of rolling processes – Types of rolling mills – Expression for rolling load – Forces and geometrical relationships in rolling – Effect of front & back tension – Friction hill – Defects in rolled product.

Extrusion: Classification of extrusion processes – Extrusion equipment's – Deformation, lubrication & defects – Extrusion of tubes & seamless pipes – Hydrostatic extrusion.

Drawing: Drawing equipment's & Dies – Determination of drawing force & power – Estimation of redundant work – Optimal cone angle & dead zone formation – Drawing variables – Tube drawing processes.

Module:3	**Sheet Metal Forming**	**5 hours**

Conventional processes, Forces in circular cup drawing, Redrawing, drawing of tubes from annular sheet dies, forming limit diagram, forming with hydrostatic pressure, explosive forming, electrohydraulic forming, magnetic pulse forming, HERF, electromagnetic forming. Forming limit criteria, defect in formed parts, principles and process parameters- Advantages -Limitations and Applications.

Module:4	**Machine Tools and Operations**	**6 hours**

Generating motions of machine tools, Machines using single-point tools, operations and process parameters – work and tool holding in engine lathe, horizontal-boring machine, shaping machine, planning machine.

Machines using multipoint tools, operations and process parameters – drilling machine, horizontal-milling machine, vertical-milling machine, broaching machine, taps and dies.

Machines using abrasive wheels, operations and process parameters – horizontal-spindle surface-grinding machine, vertical-spindle surface-grinding machine, cylindrical-grinding machine, internal-grinding machine, centerless grinding machines.

Cutting tool nomenclatures. Numerical expressions and simple problems on machining time and material removal rate.

Module:5	**Mechanics of Metal Cutting**	**7 hours**

Orthogonal & oblique cutting, shear plane angle, shear stress and strain, principal chip

types, theoretical determination of cutting forces – Ernst and Merchant's theory, Lee and Shaffer's theory, Oxley's theory. shear angle relation, friction in metal cutting, energy in cutting process, Kronenberg relation and velocity relation, chip deviation and other effects on cutting forces, stress on tool, stress distribution, Dynamometers for measuring forces in turning, milling and drilling, numerical problems.		
Module:6	**Heat Flow in Metal Cutting and Tool Life**	**7 hours**
Heat generation in metal cutting, heat at tool-work interface, heat at tool-chip interface, heat in absence of flow zone, Temperature distribution in metal cutting, Measurement of cutting temperature – Work-tool Thermocouple, direct thermocouple measurements, radiation methods, evaluation of machinability. Tool life, Taylor's equation, tool failure, variables affecting the tool life causes of tool failures, forms of wear in metal cutting, cutting tool materials, cutting Fluids, action of coolants and lubricants, application of cutting fluids, surface roughness in machining and its measurement, tool geometries for improved surface finish, economics of metal-cutting operations.		
Module:7	**Gear generation and Unconventional machining methods**	**5 hours**
Gear generating principles - Gear Hobber - Gear finishing methods - Bevel gear generator. Classification of unconventional machining process – Principle of AJM, WJM, USM, EDM, ECM, LBM – Process characteristics – Applications.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Books		
1.	B.L. Juneja, Fundamentals of Metal Forming Processes, 2010, 2nd edition, New Age International.	
2.	K.C. Jain, A.K. Chitale, Textbook of Production Engineering, 2014, PHI Learning Pvt. Ltd.	
Reference Books		
1.	George E Dieter, Mechanical Metallurgy, Tata McGraw Hill, 1988	
2.	Helmi A. Youssef, Hassan A. El-Hofy, Mahmoud H. Ahmed, Manufacturing Technology: Materials, Processes, and Equipment, 2011, CRC Press, Taylor & Francis Group	
3.	Heinz Tschaetsch, Metal Forming Practise, 2005, Springer Berlin Heidelberg New York	
4.	Hosford W.F. Caddell R.M., Metal Forming – Mechanics and Metallurgy, 2011, 4th edition, Cambridge University Press.	
5.	Geoffrey Boothroyd and Winston. A. Knight, Fundamentals of Machining and Machine Tools, 2005, CRC Press, 3rd edition	
6.	Amitabha Battacharyya, Metal Cutting: Theory and Practice, 2011, New Central Book Agency	
7.	Amitabha Ghosh and A.K. Mallik, Manufacturing Science, 2010, 2nd edition, East-West Press.	
8.	Dixit U.S. and Ganesh Narayanan R, Metal Forming: Technology and Process Modelling, 2013, McGraw-Hill Education, Noida	
9.	P.N. Rao, Manufacturing Technology: Metal Cutting and Machine Tools, 2018, Volume 2, 4th Edition, McGraw Hill Education.	
10.	Serope Kalpakjian, and Steven Schmid, Manufacturing Engineering and Technology, 2020, 8th edition, Pearson education.	
11.	P. L. B. Oxley, "The Mechanics of Machining", 1989, Ellis Horwood Ltd.	
Mode of Evaluation: CAT, Written assignment, Quiz, FAT.		
Recommended by Board of Studies	09-03-2022	
Approved by Academic Council	No. 65	Date 17-03-2022