

COURSE TITLE : **METTALLURGY AND MACHINE TOOLS**
COURSE CODE : **4023**
COURSE CATEGORY : **B**
PERIODS/ WEEK : **5**
PERIODS/ SEMESTER : **75**
CREDIT : **5**

TIME SCHEDULE

MODULE	TOPIC	PERIODS
1	Understand the structure of metals, Equilibrium diagram, heat treatment & Powder Metallurgy	20
2	Metal cutting and cutting fluids & Lathes	20
3	Drilling & Milling machines	19
4	Shaping , Slotting & Planning Machines	16
TOTAL		75

Remarks based on feedback from students, faculty, industry (revision 2010):

COURSE OUTCOME :

Sl.No.	Sub	Student Will Be Able To
1	1	Understand the structure of metals
	2	Understand the equilibrium diagram (Iron carbon, TTT diagram etc.) and heat treatment processes.
	3	Comprehend the importance of Powder Metallurgy
	4	Understand the various aspects of metal cutting and cutting fluids.
	5	Understand the classification, parts and application of lathes.
	6	Comprehend the drilling & milling processes & machines.
	7	Appreciate the shaping, slotting and planning machines and classifications.

SPECIFIC OUTCOME

MODULE I

1.1.0 Understand the structure of metals

- 1.1.1 Identify the changes in crystal structure w.r.t. temperature.
- 1.1.2 Illustrate the cooling curve for pure iron.
- 1.1.3 List the crystal defects and crystal imperfections.
- 1.1.4 Describe the crystal growth and grain formation.
- 1.1.5 State the effects on rate of cooling.
- 1.1.6 Explain the effects of grain size on properties.

- 1.1.7 Illustrate the plastic deformations of metals- slip and twinning.
- 1.1.8 Identify the property changes by deformation- work hardening, solid solution hardening, and strain hardening.

- 1.2.0** Understand the equilibrium diagram (Iron carbon, TTT diagram etc.) and heat treatment processes.
- 1.2.1 Classify the different types of alloys -Solid solutions, Inter metallic compounds & Mechanical mixture.
- 1.2.2 Explain the cooling of alloys- Eutectic, Eutectoid, Peritectic, Peritectoid .
- 1.2.3 Draw the iron-carbon equilibrium diagram.
- 1.2.4 Identify the various phases of iron-carbon equilibrium diagram.
- 1.2.5 Describe the iron-carbon equilibrium diagram.
- 1.2.6 Identify the constituents of steel from the iron-carbon equilibrium diagram.
- 1.2.7 Explain the effect of slow cooling for various compositions.
- 1.2.8 Distinguish the TTT diagram / C curve/ S curve.
- 1.2.9 Describe the Continuous Cooling Transformation diagram (CCT diagram).
- 1.2.8 Justify the needs for the heat treatment processes.
- 1.2.9 List the various heat treatment processes.
- 1.2.10 Explain the processes - annealing, normalizing, hardening, tempering, mar tempering, austempering, case hardening (cyaniding, nitriding and carburizing),
- 1.2.10 Describe the residual stress due to heat treatment.
- 1.2.12 State the methods to relieve residual stresses due to heat treatment.
- 1.2.13 Explain the Heat treatment of aluminum- age hardening
- 1.3.0 Comprehend the importance of Powder Metallurgy**
- 1.3.1 State the importance of powder metallurgy.
- 1.3.2 Describe the various methods manufacturing metal powder such as mechanical pulverization, electrolytic process, chemical reaction and atomization.
- 1.3.3 List the advantages of Powder Metallurgy.

MODULE II

2.1.0 Understand the various aspects of metal cutting

- 2.1.1 Draw the geometry of orthogonal cutting.
- 2.1.2 Explain the action of cutting tool by orthogonal cutting and oblique cutting.
- 2.1.3 Explain the chip formation with diagram.
- 2.1.4 Name the various types of chips.
- 2.1.4 Distinguish the effect of cutting speed, feed and depth of cut on cutting force.
- 2.1.5 Explain about the tool signature/ nomenclature of the single point cutting tool.
- 2.1.6 List the various cutting tool materials.
- 2.1.7 Compare the properties of various cutting tool materials
- 2.1.7 List the factors affecting the life of cutting tools
- 2.1.8 Illustrate the the term machinability of a material.
- 2.1.9 Mention the energy efficiency in metal cutting
- 2.1.10 List the factors affecting energy efficiency the metal cutting

2.2.0 Understand the various aspects of cutting fluids

- 2.2.1 List the functions of cutting fluids

- 2.2.2 Explain the desirable properties of cutting fluids
- 2.2.3 Describe the method of application of lubrication - minimum quantity lubrication (mql)
- 2.2.4 Give examples for the various types of cutting fluids and their selection for an application
- 2.2.5 Analyze the effect of coolants on cutting variables (speed, feed and depth of cut)
- 2.3.0 Understand the classification, parts and application of lathes**
- 2.3.1 List the type of lathes
- 2.3.2 Illustrate the centre lathe
- 2.3.3 Explain the functions of each part
- 2.3.4 List the various work holding devices in lathe
- 2.3.5 Explain the work holding devices
- 2.3.6 List the tool holding devices
- 2.3.7 Explain the tool holding devices
- 2.3.8 Describe the sequence of steps to be followed in performing the following operations on lathe with line sketches of turning, centering, facing, forming, taper turning, thread cutting, drilling, boring and.
- 2.3.9 Identify the tapers – standard forms- Morse taper series
- 2.3.10 List the different methods of taper turning
- 2.3.11 Determine the included angle for taper turning- by compound rest, tail stock set over method
- 2.3.12 Calculate the gear train ratio for cutting specified screw threads
- 2.3.13 Select the correct feed, speed and depth of cut for different operations for different engineering materials

MODULE III

3.1.0 Comprehend the drilling machines & processes

- 3.1.1 Classify the drilling machines
- 3.1.2 Identify the various parts of drilling machine and their functions
- 3.1.3 List the work holding devices for drilling
- 3.1.4 Explain the work holding devices for drilling
- 3.1.5 List the different types of drill bits
- 3.1.6 Explain the different types of drill bits with sketch
- 3.1.7 Give the nomenclature of taper shank twist drill.
- 3.1.8 List the different tool holding devices for drilling.
- 3.1.9 Explain tool holding devices for drilling
- 3.1.10 List the different drilling machine operations
- 3.1.11 Explain the specification of twist drill.
- 3.1.12 Describe the different drilling machine operations
- 3.1.13 Explain the specification of drilling machine
- 3.1.14 Select the feed, speed and depth of cut for a given operation.

3.2.0 Comprehend the milling machines & processes

- 3.2.1 Describe the working of different milling machines with line sketches – horizontal/ vertical.
- 3.2.2 Identify the parts and their functions.
- 3.2.3 Select the right type of milling cutter for a given operation
- 3.2.4 Illustrate the work holding devices for milling
- 3.2.5 Explain the milling cutter holding devices
- 3.2.6 Explain the milling operations.

- 3.2.7 Describe the milling methods briefly such as Up-Milling, Down milling , Plain, gang & straddle milling
- 3.2.8 Name the parts of an indexing head
- 3.2.9 Explain the different types of indexing methods- plane & direct
- 3.2.10 Describe the sequence of operations carried out by milling machines during operations such as spur gear cutting, helical gear cutting
- 3.2.11 Classify the milling cutters.
- 3.2.12 Explain the plain & end milling cutter.
- 3.2.13 Chart the speed and feed of tools for various metals.
- 3.2.14 Specify the milling machines for procurement.
- 3.2.15 Give the nomenclature of a plain milling cutter.

MODULE IV

4.1.0 Appreciate the shaping, slotting and planning machines and classifications.

- 4.1.1 **Appreciate the operations on shaping, planning and slotting machines**
- 4.1.2 State the working principle of shaping, slotting and planning machines with line sketches
- 4.1.3 Identify the parts and functions of each part.
- 4.1.4 Mention the different types of operations on these machines
- 4.1.5 Explain the quick return motion arrangements such as crank and slotted lever method, Whitworth method and hydraulic method for a shaping machine.
- 4.1.6 Explain the automatic feed mechanism in shaper.
- 4.1.7 Illustrate the quick return arrangements for a slotter by line diagram
- 4.1.8 Describe the method of table drive of a planning machine.
- 4.1.9 Indicate the mode of specifying these machines for procurement
- 4.1.10 Compare shaper, slotter and planer.

CONTENT DETAILS

MODULE I

Explain Structure of materials- Changes in Crystal Structure w.r.t. temperature.- Crystal Defects- crystal imperfections-crystal growth and grain formation- Deformations of metal- rate of cooling- grain size on properties- Property changes by deformation- work hardening- solid solution hardening- strain hardening- age hardening.

Heat Treatment Processes-Alloys and Phase diagram- types alloys-Solid solutions- Inter metallic compounds- Mechanical mixture- cooling of alloy- Eutectic- Eutectoid- Peritectic- Peritectoid- Cooling Curve for Pure iron- iron-carbon equilibrium diagram- constituents of steel from the iron-carbon equilibrium diagram- effect of slow cooling for various composition- TTT diagram/C curve/ S curve. Continuous cooling transformation diagram (CCT diagram)-heat treatment process- annealing-normalizing- hardening- tempering- mar tempering- austempering- case hardening (cyaniding- nitriding and carbonizing)-residual stress due to heat treatment- age hardening.

Powder metallurgy

Importance - various stages of manufacturing-advantages- applications.

MODULE II

Metal cutting

Orthogonal cutting and oblique cutting- chip formation -type of chips- cutting speed - feed and depth of cut - tool signature/ nomenclature of the single point cutting tool- 1.2.8 State the properties of various cutting tool materials- tool life problems- machinability- nomenclature of taper shank Twist drill- plain milling cutters. cutting tool material-lathe -drilling- milling- shaper.

Cutting fluids

Lubricants- coolants - requirement- properties- method of application- selection.

Lathe and lathe work

Type of lathe – Centre lathe- Tool room lathe- Bench lathe and Speed lathe. Lathe construction – lathe parts- function of each part - Lathe accessories – work holding and tool holding devices. Metal cutting – speeds- feeds and depths of cut of different operation for different materials- Operations – cylindrical turning - time calculation and measurements- taper turning methods- thread standards and forms- thread calculation- gear changing for screw cutting- drilling- boring- reaming-Lathe specification.

MODULE III

Drilling machines – classification- work holding devices- types of drill bits- tool holding devices drilling machine operations- feed- speed and depth of cut for a given operation- specification.

Milling machines-General use of milling machines- Parts of milling machines and their functions- Types of milling machines -(a) plain (b) universal- Cutter holding devices (a) arbours (b) collets (c) adapters- Setting of work –(a) work holding devices (b) alignment (c) speed feed and depth of cut on various materials- Milling operations - plain milling- key and key ways- gang milling- T – slot milling - Milling methods (a) conventional milling (b) climb milling- Constructions on indexing head (name of the parts only).types of indexing- spur gear cutting- milling cutters- Milling machine specifications.

MODULE IV

Shaping Machines- shaper-use – parts and their functions – shaper tool holding devices- Quick return motion- arrangements and adjustments of stroke- crank and slotted lever method With worth method- Hydraulic method- automatic feed mechanism- speed- feed and depth of cut for various materials- Shaper specifications.

Slotting Machines- slotter use- Slotter parts and their functions- Tools and work holding devices- Speed feed and depth of cut for various materials- quick return arrangements- specifications.

Planing machines-planer-use- planer parts – functions- Tool - work holding devices- Table drive- feeds- specifications.

TEXT BOOK

1. Work shop technology Vol- I,II - S.K Hajra Choudhary,S.K.Bose, A.K. Hajra Choudhary, Nirjhar roy
2. Engineering materials and metallurgy- R. Srinivasan

REFERENCE

1. Manufacturing processes – serope kalpakjain, steven.r.schmid
2. W/S Technology - B.S. Reghuwanshi
3. Production technology - Er.R.K. Jain
4. Enginnering materials- b.k. Agarwal
5. Production Technology - P.C. Sharma Pub: S. Chand and Co.
6. Powder Metallurgy: Science, Technology and Applications - Angelo & Subramanian
7. Materials Science and Engineering: A First Course, 5th ed - Raghavan