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

TIME SCHEDULE

<table>
<thead>
<tr>
<th>MODULE</th>
<th>TOPIC</th>
<th>PERIODS</th>
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<tbody>
<tr>
<td>1</td>
<td>Understand the structure of metals, Equilibrium diagram, heat treatment &amp; Powder Metallurgy</td>
<td>20</td>
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<td>2</td>
<td>Metal cutting and cutting fluids &amp; Lathes</td>
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<td>3</td>
<td>Drilling &amp; Milling machines</td>
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<td>4</td>
<td>Shaping, Slotting &amp; Planning Machines</td>
<td>16</td>
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<td>TOTAL</td>
<td>75</td>
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Remarks based on feedback from students, faculty, industry (revision 2010):

COURSE OUTCOME:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Sub</th>
<th>Student Will Be Able To</th>
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<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Understand the structure of metals</td>
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<td>2</td>
<td>Understand the equilibrium diagram (Iron carbon, TTT diagram etc.) and heat treatment processes.</td>
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<td>3</td>
<td>Comprehend the importance of Powder Metallurgy</td>
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<td>4</td>
<td>Understand the various aspects of metal cutting and cutting fluids.</td>
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<td>5</td>
<td>Understand the classification, parts and application of lathes.</td>
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<td>6</td>
<td>Comprehend the drilling &amp; milling processes &amp; machines.</td>
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<td>7</td>
<td>Appreciate the shaping, slotting and planning machines and classifications.</td>
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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).
1.2.10 Justify the needs for the heat treatment processes.
1.2.11 List the various heat treatment processes.
1.2.12 Explain the processes - annealing, normalizing, hardening, tempering, mar tempering, austempering, case hardening (cyaniding, nitriding and carburizing).
1.2.13 Describe the residual stress due to heat treatment.
1.2.14 State the methods to relieve residual stresses due to heat treatment.
1.2.15 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.
2.1.5 Distinguish the effect of cutting speed, feed and depth of cut on cutting force.
2.1.6 Explain about the tool signature/ nomenclature of the single point cutting tool.
2.1.7 List the various cutting tool materials.
2.1.8 Compare the properties of various cutting tool materials
2.1.9 List the factors affecting the life of cutting tools
2.1.10 Illustrate the the term machinability of a material.
2.1.11 Mention the energy efficiency in metal cutting
2.1.12 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

Lathe and lathe work

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) adopters - 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


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.

Planning machines - planer use - planer parts - functions - Tool - work holding devices - Table drive - feeds - specifications.
TEXT BOOK

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. Engineerning materials- b.k. Agarwal
7. Materials Science and Engineering: A First Course, 5th ed - Raghavan