B.E. 5TH SEMESTER (ME) FINAL EXAMINATIONS, 2011

## Machine Tools & Metal Cutting (ME – 504)

**Full Marks: 70** **Time: 3 hrs**

**Use separate answer script for each half.**
**Answer SIX questions, taking THREE from each half.**
**All questions carry equal marks.**

# FIRST HALF

1. (a) How the lathes are specified?
   (b) Name the principal parts of a lathe.
   (c) The speed gear box of a lathe has to be designed for turning of 20 mm to 400 mm diameter jobs with an average cutting speed of 20m/min. If there are 8 speed steps of the gear box, find out the speeds in rpm. Support your design decisions with appropriate considerations.

2. (a) What are the different operations that can be performed in lathe?
   (b) Detail out different methods of taper turning performed on lathe.
   (c) It is required to cut a screw having 4 mm pitch on a lathe having leadscrew of 4 threads per inch. Calculate the gears.

3. (a) State the differences between a shaper and a planning machine.
   (b) Explain, with the help of suitable diagram, the crank and rocker arm mechanism used in shaper.
   (c) Deduce the expression of cutting velocity in shaping operation with respect to rpm of the bull gear, length of cutting stroke and the ratio of return stoke time to cutting stroke time.

4. (a) Classify different types of drilling machines.
   (b) Draw a neat sketch of radial drilling machine.
   (c) Draw a neat sketch of a two fluted twist drill with proper labeling.

5. (a) What do you understand by 'machinability' of a material? What does it signify when it is stated that material-A is more machinable than material-B?
   (b) Define 'machinability index' and rearrange the following materials with increasing value of machinability index: (i) SAE1112 steel, (ii) Stainless steel, (iii) Copper, (iv) Brass.
   (c) Discuss how the application of cutting fluid improves the overall machining performance. What are the desirable properties of an ideal cutting fluid?

## SECOND HALF

6. (a) Why a nose radius is usually provided on turning tool ?

   (b) A single point turning tool is specified as "$8^\circ - 8^\circ - 6^\circ - 6^\circ - 30^\circ - 45^\circ - \frac{1}{4}$ inch", draw the different views of the tool and label the tool angles.

   (c) Determine the orthogonal rake angle ($\gamma_o$) and inclination angle ($\lambda$) of the above tool. Deduce the formula you use.

7. (a) Discuss the role of cutting edge angle ($\phi$) in turning operation performed on lathe.

   (b) With necessary sketches describe the different types of chip formation during machining operation.

   (c) During cylindrical turning operation of a 20 mm diameter shaft with a single point tool, having signature "$0^\circ - 5^\circ - 6^\circ - 6^\circ - 20^\circ - 60^\circ$ – 1mm", the tool was by mistake fixed 0.7 mm below the desired position. With necessary sketch show how the tool angles have changed. Calculate the effective tool angles.

8. (a) What do you understand by 'tool life'? State the Taylor's tool life equation.

   (b) Plot the flank wear ($h_f$) versus machining time (T) diagram for a single point turning tool and explain the salient features of the diagram.

   (c) Mild steel rods of diameter 50 mm are to be turned over a length of 160 mm with HSS tool. The depth of cut d = 1.5 mm, feed f = 0.2 mm/ rev, and spindle speed N = 230 rpm. If the tool life equation is given by:

   $$VT^{0.2} f^{0.3} d^{0.12} = 50$$

   Determine how many components can be turned before regrinding the tool.

9. (a) Define the terms chip reduction coefficient ($\xi$) and shear angle ($\theta$) in machining operation.

   (b) Derive the expression for shear strain ($\varepsilon$) in orthogonal machining operation.

   (c) A mild steel shaft is being turned with a HSS tool, having signature "$0^\circ - (-5^\circ) - 6^\circ - 6^\circ - 20^\circ - 45^\circ$ – 1mm", with a feed rate 1.25 mm/ rev. If the actual chip thickness is 1.82 mm, find (i) Chip reduction coefficient ($\xi$), (ii) Shear angle ($\theta$) and (iii) Shear strain ($\varepsilon$).

10. (a) State the assumptions made by Merchant for his theory on machining forces.

    (b) Draw the Merchant's diagram and show the different force components in orthogonal machining operation. Derive the equations for cutting force ($F_C$) and thrust force ($F_T$) in terms of material properties and process parameters.

    (c) During orthogonal machining of mild steel, the following data were obtained: Cutting force ($F_C$) = 950 N, thrust force ($F_T$) = 475 N, chip thickness ($a_c$) = 0.75 mm, uncut chip thickness (a) = 0.25 mm, cut width (w) = 2.5 mm, rake angle ($\gamma_o$) = $0^\circ$. Find the coefficient of friction ($\mu$) between chip and rake surface, and the shear stress in job material ($\tau$).