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MANIPAL INSTITUTE OF TECHNOLOGY
A Constituent Institute of Manipal University, Manipal

I SEM M. Tech. (MANUFACTURING ENGG & TECHNOLOGY) DEGREE END SEMESTER EXAMINATIONS, NOVEMBER 2017

SUBJECT: THEORY OF METAL CUTTING (MME 5123)
REVISED CREDIT SYSTEM

Time: 3 Hours Max. Marks: 50

Instructions to Candidates:
- Answer **ALL** questions.
- Missing data, if any, may be assumed appropriately.

1. a) Discuss the tool point reference system and its application to specify the geometry of single point cutting tool **[05]**

   b) Obtain the differential equation for heat transfer in a moving material with specific reference to orthogonal machining. **[05]**

2. a) What is tool chatter? Discuss the influence of vibration on tool life. **[04]**

   b) The following data were observed during orthogonal machining: **[06]**

   Normal rake angle = 20°
   Cutting speed = 100 m/min
   Uncut chip thickness = 0.125 mm
   Width of cut = 4 mm
   Chip thickness ratio = 0.45
   Cutting force = 1100 N
   Thrust force = 400 N
   Chip-tool contact length = 0.3 mm
   Exponent of normal stress distribution on rake = 0.4

   Estimate the following:

   i) Shear plane angle
   ii) Friction angle
   iii) Maximum normal stress on rake
   iv) Shearing and chip velocities

3. a) Discuss the characteristics and applications of the following cutting tool materials:
    i) High Speed Steel (HSS)
    ii) Cubic Boron Nitride (CBN) **[06]**

   b) When machining steel with HSS tools, the following equation was found to fit the tool life data fairly well

   $$V\,T^{0.2} f^{0.75} d^{0.35} = 243.5$$

   Calculate the tool life T at a cutting speed V = 50m/min, feed f = 0.25 mm/rev and depth of cut d = 0.5 mm. Calculate the effect of tool life if the above parameters are increased by 20% individually. **[04]**

4. a) Discuss the phenomenon of tool damage during machining due to progressive flank wear **[04]**

   b) Show that, when machining material orthogonally with a tool of zero rake angles, the rate of heat generation, Qs, in the shear plane is given by

   $$Q_s = F_c V (1 - \mu r_c)$$

   Where, F_c = cutting force
    V = cutting speed
    μ = mean coefficient of friction on the tool face
    r_c = cutting ratio = t/t_c
    t = undeformed chip thickness
    t_c = chip thickness

   Then, for the same tool and machining conditions calculate the portion of heat carried by the chip (1-λ) and the shear-plane temperature rise θ_s when the material has a specific cutting energy (cutting force per unit area of undeformed chip) of 2.8×10^9 N/m^2, cutting speed V = 100 m/min, μ = 0.4, r_c = 0.2, width of cut b = 2.5 mm and undeformed chip thickness t = 0.25mm. Assume that the work material has density ρ = 7200 kg/m^3, diffusivity ξ_s = 1 and specific heat C = 500 J/kg K. **[06]**

5. a) Discuss the influence of the following on cutting tool life: **[04]**
    i) Tool geometry
    ii) Work material properties

   b) Discuss with an illustration the influence of tool edge with finite radius on forces during orthogonal machining and method of estimating the ploughing force. **[06]**