IIT Indore
Discipline of Mechanical Engineering
# ME 305: Machining Science and Metrology
Online End Semester Examination (2021)

**Duration: 3 Hours** **Full Marks: 40**

*Note: Answer all the questions given below.*
*Write your **Name, Roll no. and Page no.** on top of each page of your answer sheets.*

---

1. Show the different wear patterns of a single point turning tool (SPTT) by using proper engineering drawing. [5]

2. a) "Although cutting temperature is increased with increasing principal cutting edge angle ($\phi$), high principal cutting edge angle is provided to the SPTT": Why? [2]

   b) "Having nose radius of a single point turning tool is beneficial in terms of producing a smooth surface": Prove it with proper derivation. [3]

3. For a specific cutting condition by a cemented carbide tool insert, the Taylor's tool life equation is given by $VT^{0.2} = 152$. The following condition is given:

   i) Cutting velocity range of the tool: 80 m/min – 100 m/min
   ii) Specification of the tool insert is given as "SNUN 12 03 08"
   iii) Cost of the insert is Rs. 500
   iv) Tip change time is 0.5 min
   v) Cost of the blank and electricity consumed is Rs. 300
   vi) Labour cost is Rs. 20/min

   If a single insert is totally consumed for producing a single work piece at maximum production rate,

   a) How much will be the total life of the insert
   b) How much will be the cost of production of a single work [3+2]

4. A brittle material with flow strength of 4 GPa is to be cut by using AJM process. If the abrasive flow rate is 2 gm/min, velocity of the jet is 200 m/s, density of the grit material is 3 gm/cc and the grit size is 60 μm, then find:
   a) Material removal rate (MRR) of AJM
   b) Material removal per impact
   c) Radius of indentation produced by a single grit [2+2+1]

5. Derive the following expression to find the total force applied by the tool while cutting brittle material using USM process. *(The standard assumptions are to be considered)*

$$\mathbf{F = (3AC)\ (\sigma_w/4a_o)\mu.\delta_w^2\ (1+\ \sigma_w/\ \sigma_T)}$$

Where, A = Area of the tool face
C = Concentration of abrasive in the slurry
$\sigma_w$= Flow stress of work-piece material
$\sigma_T$ = Flow stress of tool material
$a_o$ = Amplitude of the frequency
$\delta_w$ = Indentation depth of work-piece by a single grit
$\mu$ = Grit factor [5]

6. Composition of a cobalt based alloy is as follows: Cobalt = 54%, Chromium = 26%, Nickel = 9%, Molybdenum = 5%, Iron = 3% and rest Tungsten. If the alloy is to be machined by ECM process calculate the rate of dissolution if the area of the tool is 1200 $mm^2$ and a current of 500 A is being passed through the cell. (Assume dissolution to take place at the lowest possible stable valences of the following elements). Given:

| **Element** | **Atomic weight (gm)** | **Density (gm/cc)** |
|---|---|---|
| Cobalt | 58.9 | 8.9 |
| Chromium | 51.9 | 7.2 |
| Nickel | 58.7 | 8.9 |
| Molybdenum | 95.9 | 10.28 |
| Iron | 55.85 | 7.86 |
| Tungsten | 183.8 | 19.25 |

[5]

7. In an EDM process if the open circuit voltage ($V_o$) is 100V, $V_d^*$= 25V and spark energy is 0.6 J determine the discharge time ($t_d$). Generator is expected to have maximum power output during charging and the machine resistance ($R_m$) is 0.5 Ω. [5]

8. For AWJM of steel work piece with following machining conditions find out the depth of penetration. Consider ideal situation with no loss of velocities and all coefficients to be 1.

Given:
Incoming water pressure: 4000 bar
Orifice diameter: 0.25 mm
Focus tube/insert diameter: 2 mm
Mass flow rate of abrasives: 1 kg/min
Traverse speed of jet: 200 mm/min
Specific energy of steel: 13.6 $J/mm^3$ [5]