Material Removal Processes (MCL 136)
Minor II Exam

F.M. 20 Time 1 hr

All answers must be brief and to the point. Assume any relevant data wherever required. All parts of a question must be answered together.

1. Answer in brief the followings: 5x2=10
   a. Mention the major limitations of cutting force analysis by Merchant's Circle Diagram?
   b. Mention any two major detrimental effects of high cutting temperature on the work-piece and also on the cutting tool?
   c. What are the major principles normally adopted for measuring the cutting forces?
   d. Explain with proper reasoning, what type of cutting fluid is normally recommended for machining of High Strength Alloy steels using coated carbide tools?
   e. Define Gauge factor of strain gauges. Distinguish between a half bridge and full bridge Wheatstone bridge circuit used for measuring strains.

2. Orthogonal turning is performed on a cylindrical workpiece with the shear strength of 250 MPa. The following conditions are used: cutting velocity is 180 m/min, feed is 0.20 mm/rev, depth of cut is 3 mm, cutting ratio (r) = 0.5. The orthogonal rake angle is 7^0. Applying Merchant's theory for analysis, find out the main cutting force and the friction force. 3

3. Analytically estimate the average shear zone temperature, θ_s for plain turning of mild steel rod of diameter 200 mm by a carbide tool of geometry 5^o, 4^o, 6^o, 5^o, 15^o, 75^o, 0.8 (mm) ORS at rotational speed of 1000 rpm, feed 0.1 mm/rev and depth of cut 2.0 mm under dry condition when the followings were noted: Main cutting force component, P_z= 1200 N, Frictional force at the rake surface, F = 500 N, Chip thickness, a_2= 0.5 mm.
   Assume : 80% of mechanical energy gets converted into heat, 90% of the heat generated at the shear zone goes into the chips, Mechanical equivalent of heat, J = 4.2 J/Cal, Volume specific heat of mild steel, C_v=3600KJ/m^3 ^oC. Ambient temperature, $\theta_a = 30^o$ C. 3

4. With an example, define thermo-chemical wear of cutting tool during machining process. How is the rake crater depth measured after the machining operation? 1.5+0.5 = 2

5. Mention how the cutting tool tip temperature can be evaluated during turning of a metallic alloy by a ceramic too insert? What is cryo-machining? 1.5+0.5 = 2