BITS PILANI - K. K. BIRLA GOA CAMPUS

Mid semester examination

Subject: Advanced Manufacturing Processes (ME F315)

Full marks: 50

Date:31/10/2022 **Duration: 90 minutes**

Instructions: (i) Answer all the questions. (ii) Show each step to get full credit.

PART A

1. Explain reason and show with the graph how change in abrasive grain size affects (i) surface finish and (ii) material removal rate in USM process in case of brittle materials. **[2]**

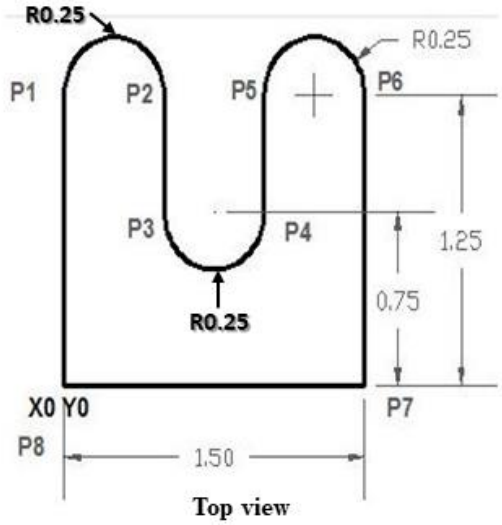
2. Calculate total angular movement (degrees) of a leadscrew with a pitch of 5 mm to drive the worktable by a distance of 200 mm in a NC machine. **[4]**

3. There is a horn which has to work at 19 kHz. At the transducer end, the horn has a cross section of 25×25 mm^2 and this exponentially tapers off to 25×4 mm^2 at the tool end. It is made of steel and speed of sound in the medium is 5000 m/s. Find out what is the length of the horn?

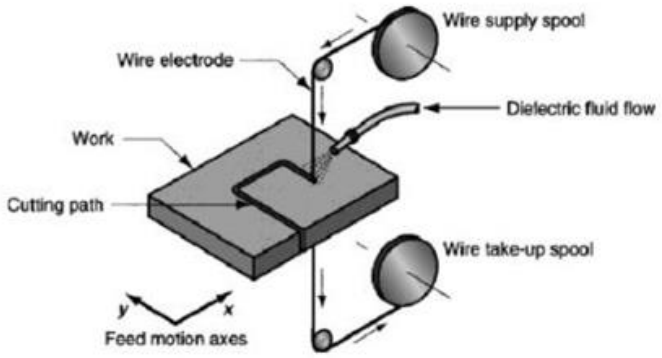
[4]

PART B

1. You are assigned to write a part program without use of canned cycle for the profile shown below on a rectangular metallic plate held on a CNC machine. A wire EDM machine utilizes an electrically energized thin wire of negligible diameter to cut the material. Thickness of the workpiece is 5 mm, and can be cut in one pass. Working principle of Wire EDM is shown in the figure below. Make suitable assumptions if required. Use absolute coordinates to write the program. Write comment if necessary. **[10]**



Top view



2. A student calculates the material removal rate in USM to be 5 mm^3/min for a particular case where c=0.65, c = concentration of abrasives in slurry
He has used the following expression for the calculation: $\boldsymbol{MRR = K \times c^{\frac{1}{4}}}$
K=constant, MRR is in mm^3/s
However, when he does the experiment for the same case, he finds that due to settling down of abrasives at the bottom of the tank, the concentration reduces with time as per the relation c=0.65×e^(−(t/100)) where, t is time in seconds
If starting concentration at t= 0 is c=0.65, find the total material removal rate in the experiment in the first minute. **[10]**

3. A factory is carrying out a specific grooving operation on metallic parts by a AWJM machine, in which abrasive consumption rate = 0.6 kg/min, water mass flow rate = 3.79 kg/min. The factory runs the machine continuously for 8 hours per day (1 shift in 1 day). This year, a severe water shortage occurs and the factory is not permitted to use more than 1500 litres of water per day, for AWJM. But water mass flow rate in AWJM cannot be changed. The management takes a decision to change the abrasive mass flow rate and run the machine for as many hours as possible in 1 shift per day and thus finish the same number of metallic jobs (with same specifications) as done in 8 hours per day previously. (i) For how many hours can the machine be run per shift (in 1 day) with changed settings? (ii) Find the changed abrasive mass flow rate for the changed settings (Assume: groove width remains constant for any setting. R = loading ratio should not be set to more than 1; 1 litre of water weighs 1 kg and all standard assumptions of AWJM are applicable, all loss factors to be taken as unity). (iii) What is the value of loading ratio R with changed settings? **[1+7+2]**

Penetration depth for AWJM:

$$\boldsymbol{h_t = C_d \times \frac{\pi}{4} \times d_o^{\,2} \times R \times \left(\frac{\eta}{(1+R)}\right)^2 \times \frac{p_w^{\frac{3}{2}}}{u_{job}\, d_i\, v_f} \sqrt{\frac{2}{\rho_w}}}$$

4. Your neighboring country has purchased an anti-aircraft gun with a muzzle output velocity of 550 m/s and the projectiles (fired from the gun) are of spherical shape and made of solid iron with density 7.5 g/cc (no explosive inside the projectile). Your army helicopters are being targeted and the defense department asks you to determine a safe flying height at which the indentation damage depth can be a maximum of 5% of the projectile diameter. The helicopter body is covered with TiB_2 plates of hardness 3000 kgf/mm^2. You can apply the theory of damage caused by abrasives as in AJM. Neglect wind effects and do not neglect gravity, g=10 m/s^2.