Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2016/2017



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| COURSE NAME | : | MODERN MACHINING PROCESS |
| COURSE CODE | : | BDD 40703 |
| PROGRAMME | : | 4 BDD |
| EXAMINATION DATE | : | DECEMBER 2016/JANUARY 2017 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER **FIVE (5) QUESTIONS** OUT OF SIX (6) QUESTIONS |

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

**Q1** (a) Differentiates between transferred plasma arc and non-transferred plasma arc in term of their components and circuit diagram.

(4 marks)

(b) Explain the effect of plasma arc temperature in terms of kerf width and hardness of the machined surface.

(6 marks)

(c) Dual gas plasma torch and water injected plasma are the two common plasma arc cutting system available in the market. Compare these systems in terms of the working principle, main gases, shielded gases and recommended workpiece.

(10 marks)

**Q2** (a) Quench hardening is mechanical process in which a steel is strengthened and hardened. Explain how electron beam technique can be used in the quenching process.

(6 marks)

(b) A through hole with a depth of 3 mm is to be drilled by electron beam machining (EBM). The beam was running at the frequency, acceleration voltage and emission current of 0.05 $sec^{-1}$ 50 kV and 140 mA. The average beam diameter and constant ($K_b$) can be assumed as 0.5 mm and 0.138. Calculate:

i. The machining time.
ii. Drilling rate (mm/min)
iii. Volumetric removal rate ($mm^3$/min)

(6 marks)

(c) The Production Department noticed that the productivity is too slow to produce the product in **Q2(b)**. As a Process Engineer, you need to improve the production yield. Propose two solutions to double up the productivity rate.

(8 marks)

**Q3** (a) More than 50% of the machine tools error and accuracy in High Speed Machining Center are due to the temperature. The sources of heat might be from the bearing, slide ways and motor. As an engineer in the Machine

Tools Department, you need to work out on these issues. Propose the methods or solutions for these issues.

(8 marks)

(b) Appropriate material selection, good design and construction are essential especially in high speed machine structure to provide stiffness and good damping performance. Discuss each of them.

(4 marks)

(c) A single slot with the length, width and depth of cut of 100 mm, 10 mm and 5 mm respectively, need to be cut using a carbide cutting tool. The cutting tool has a diameter and number of teeth of 10 mm and 4 respectively. The cutting speed of 150 m/min and feed of 0.25 mm/tooth will be employed during the operation. The cutting force and thrust force measured during machining are 1500 N and 900 N respectively. Calculate:

i. Material removal rate ($mm^3$/min) of this operation.
ii. Required power to perform the operation (Watt).
iii. Specific energy ($Nm/mm^3$)

(8 marks)



**Q4** (a) Differentiate between water jet and abrasive water jet machining.

(6 marks)

(b) Explain the effect of the following parameters on Water Jet cutting performance:

i. Stand of distance (SOD) on material removal rate (MRR).
ii. Cutting speed on kerf.

(6 marks)

(c) An abrasive water jet machining (AWJM) is used to cut an aluminium thin plate with the thickness of 5 mm. This machine is equipped with an orifice with the diameter of 0.2 mm. The water was pumped with the pressure of 4000 bar. The mass flow rate for an abrasive is 1.5 kg $min^{-1}$.

i. If there is no loses during the process, determine the water jet velocity ($ms^{-1}$).
ii. Determine the mass flow rate of water (kg/min).
iii. Calculate the abrasive velocity ($ms^{-1}$).

(8 marks)

**Q5** (a) Etchant solution is essential in order to obtain better machining performance. However, the performance of etching process is depends on the work material, material removal rate and surface finish. Evaluate these factors by giving a supporting statement in order to defend it.

(6 marks)

(b) **Figure Q5(b)** shows a miniature component used a medical device. As a process engineer, you have identified that electrochemical machining (ECM) is the most suitable process to produce it. Propose and sketch the machine and tooling setup in order to produce the component and explain the working principle of that particular process.

(8 marks)

(c) A through hole with the diameter of 1.5 mm is to be cut in a pure iron workpiece by electrochemical machining (ECM). The thickness of the workpiece is 2 mm. To spread the cutting process, the electrode tool will have a center hole of 1 mm, which will produce a center core that can be removed after the tool breaks through. If the voltage is 10 V and specific removal rate for pure iron is $3.69 \times 10^{-2}$ $mm^3$/amp.sec, calculate:

i. Required current to complete the machining operation in 20 minutes.
ii. The working gap (mm), if the resistivity of the electrolyte is 120 ohm-mm.
iii. Material removal rate.

(6 marks)



**Q6** (a) By the aid of a diagram, explain the basic operating principle of ultrasonic machining (USM).

(5 marks)

(b) As a Process Engineer, you need to monitor the performance of USM process to ensure it is running at 100% efficiency. However, one day you notice that the efficiency of the process in terms of material removal rate (MRR) was drastically decreased to 85%. Identify two of the reasons, propose and explain the solutions to improve the efficiency.

(10 marks)

(c) A hole of diameter 6 mm in tungsten carbide plate (fracture hardness = 6900 $N/mm^2$) is produced by using a USM. The thickness of the plate is 5 mm. The mean abrasive grain size is 20 μm diameter. The feed force is equal to 5 N. The amplitude of tool oscillation is 30 μm and the frequency is equal to 15 kHz. The tool material used is copper having fracture

hardness equal to 1.5 x $10^3$ N/mm$^2$. The slurry contains one part abrasives to one part water. Take the values of different constants as $k_1$ = 0.3, $k_2$ = 1.8 mm$^2$, $k_3$ = 0.6, and abrasive density = 3.8 g/cm$^3$. Using a grain-throwing model, calculate:

i. Depth of penetration, $h_{th}$.
ii. Volumetric material removal rate, VRR.
iii. Machining time.

(5 marks)

**- END OF QUESTION –**

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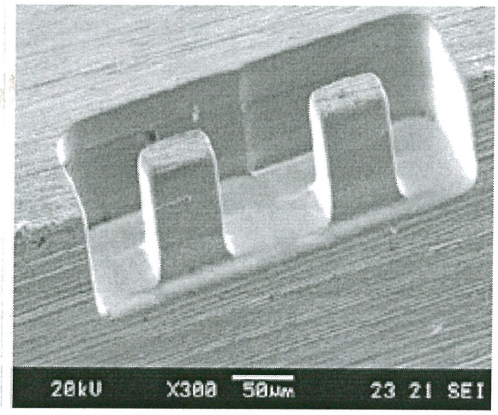


**Figure Q5(b)**