UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	MODERN MACHINING PROCESS
COURSE CODE	:	BDD 40703
PROGRAMME	:	4 BDD
EXAMINATION DATE	:	JUNE / JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL QUESTIONS** IN SECTION A AND **THREE (3) QUESTIONS** IN SECTION B

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

SECTION A

Q1 (a) Coherent is one of the laser light characteristic. Explain about it.

(2 marks)

(b) Explain the reasons why laser pumped is more efficient than lamp pumped in laser pumping system.

(6 marks)

(c) A two thin sheets metal need to be welded using a Gaussian laser with a spot diameter of 0.7 mm. The workpiece has a thermal conductivity (K) of 6.0 W/(mK). In addition, the laser absorptivity (A) and melting temperature values are 0.4 and 900 K, respectively. Calculate:

i. Minimum power to be generated to melt the sheet metal
ii. If the laser used is a pulse wave laser and the average laser power was 200 W, calculate the peak power value by assuming that the pulse wave is flat top pattern.

(6 marks)

(d) **Figure Q1(d)** shows the formation of heat affected zone (HAZ) when applying laser beam on the workpiece surface. From this result, it shows two different results where HAZ of B is deeper than A. Analyze this result by giving and explaining the factors that affect the HAZ.

(6 marks)

Q2 (a) Electrical Discharge Machining (EDM) is rarely used in mold and die industries. It is due to the application of high speed machining. Explain why high speed machining is more suitable in these industries.

(2 marks)

(b) Plasma cutting is a process that cuts through electrically conductive materials by means of an accelerated jet of hot plasma. Explain the working principle of plasma cutting.

(4 marks)

(c) Chemical etching is typically a combination of either an acid or base with an oxidizing or reducing agent in a solute such as an alcohol. The performance of etching process is depends on the work material and acid concentration. Evaluate these factors by giving a justification, clarification and example in order to defend it.

(6 marks)

(d) A deep core needs to be machined on the injection mold core plate using an Electrical Discharge Machining (EDM) process. During the process, your machinist has observed and reported to you that the debris from the eroded material was accumulated at the bottom surface of core. At the same time, the quality of the machined surface was not so good. As a Tooling Engineer, you need to solve these issues by looking at any potential solution. By using a Fish Bone Diagram, find the root cause of this problems and propose a solutions to improve the efficiency.

(8 marks)

SECTION B

Q3 (a) An abrasive water jet machining (AWJM) is used to cut a stainless steel plate with a thickness of 7 mm. This machine is equipped with an orifice diameter of 0.7 mm. The water was pumped with the pressure of 1000 bar. The mass flow rate for an abrasive is 1.0 kg min^{-1}.

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

(4 marks)

(b) A water jet cutter, also known as a waterjet, is an industrial tool capable of cutting a wide variety of materials using a very high-pressure jet of water, or a mixture of water and an abrasive substance. There are two types of waterjets; the pure waterjet and the abrasive waterjet. Differentiate between these processes in terms of their nozzle design and construction.

(6 marks)

(c) A sheet metal needed to be cut with the specifications of (i) no burr on the edges, (ii) fast cutting, no waste of material and (iii) free from heat affected zone. In the production floor, you have laser cutting machine, water jet and abrasive water jet processes. As a Production Engineer, you need to decide which process is suitable to run the job. Base on your justification, which machine run better in the above cases.

(10 marks)

Q4 (a) A blind hole with a depth of 1.5 mm is to be drilled by electron beam machining (EBM). The machine was set to a frequency, acceleration voltage and emission current of 0.2 sec^{-1}, 65 kV and 170 mA, respectively. By assuming that the average beam diameter and beam constant (K_b) are 0.5 mm and 0.15, respectively, calculate:

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

(4 marks)

(b) The electron beam is normally being generated from the electron gun. The construction of electron gun consists of several important components, such as a lens system. This system is divided into two sections, (i) magnetic lenses and apertures and (ii) electromagnetic lens and deflection coil. With the aid of diagram, differentiate between these two sections in terms of its function.

(6 marks)

(c) Quality Engineering Department has conducted an inspection and found that the surface quality after EBM process is not met the specification. The result showed that the value of surface roughness is slightly higher that the required value given in the specification. As a Process Engineer, you need to improve the product's quality. Using a Fish Bone Diagram, determine the root causes, provide a solutions and its justifications.

(10 marks)

Q5 (a) A 1.5 mm diameter of hole needs to be drilled on a 3 mm thickness of chromium steel plate (fracture hardness = 5500 N/mm^2) using a ultrasonic machining (USM). The slurry is mixed with an abrasive with a mean grain size is 20 μm diameter. The slurry ratio has one part of abrasives and one part of water. The feed force is is set at 3 N. The amplitude of tool oscillation and frequency are 15 μm and 25 kHz, respectively. The tool material is made from copper tungsten having fracture hardness of 3.0 x 10^3 N/mm^2. Take the values of different constants as k_1 = 0.2, k_2 = 1.8 mm^2, k_3 = 0.5, and abrasive density = 5 g/cm^3. Using a grain-throwing model, calculate:

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

(4 marks)

(b) **Table 1** shows the type of abrasive and its properties used in the USM process. Analyze and compare the machining performance of both abrasive in terms of material removal rate and surface roughness. You need to give a justification in your answer and relates it with the theory.

(6 marks)

Table 1 Abrasive and its properties

Workpiece	Hardness, H_v	Abrasive	Surface roughness, μm	Removal rate, $mm^3\ min^{-1}$
Brass	1200	SiC , B_4C	0.9	7.6
Tungsten carbide	3000	B_4C	0.3	0.6

(c) Daily performance of USM process in the production floor is always at the average percentage of 95%. One day, you have noticed that the performance especially its material removal rate was dropped drastically to 80%. As a Production Engineer, you need to solve this issue to meet your daily production schedule. By using a Fish Bone Diagram technique, identify the causes and propose a solutions to improve the efficiency.

(10 marks)

Q6 (a) A blind hole with a diameter and depth of 1 mm and 1.5 mm, respectively need to be cut in a stainless steel workpiece by electrochemical machining (ECM). To spread the cutting process, the electrode tool must have a center hole of 0.1 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 cast iron is 2.00×10^{-2} mm^3/amp.sec, calculate:

i. Value of current to complete the machining operation in 5 minutes
ii. The working gap (mm), if the resistivity of the electrolyte is 50 ohm-mm
iii. Material removal rate

(4 marks)

(b) **Table 2** shows the type of workpiece and its properties to be used in ECM process. Compare the machining performance of both workpiece materials in terms of their material removal rate. You need to give a justification in your answer and relates it with the theory.

Table 2 Removal rate in electrochemical machining

Workpiece	Atomic weight	Valence	Density ($g\ cm^{-3}$)	Mass ($kg\ h^{-1}$)	Volume ($mm^3 \times 10^3\ min^{-1}$)
Copper	63.57	1	9.0	3	5
Chromium	51.99	2	7.19	1	3

(6 marks)

(c) **Figure Q6(c)** shows a miniature component used in electronic device. As a process engineer, you have identified that ECM is the most suitable process to produce it. Propose the machine and tooling setup and explain the working principle of the process in order to produce that component.

(10 marks)

- END OF QUESTION –

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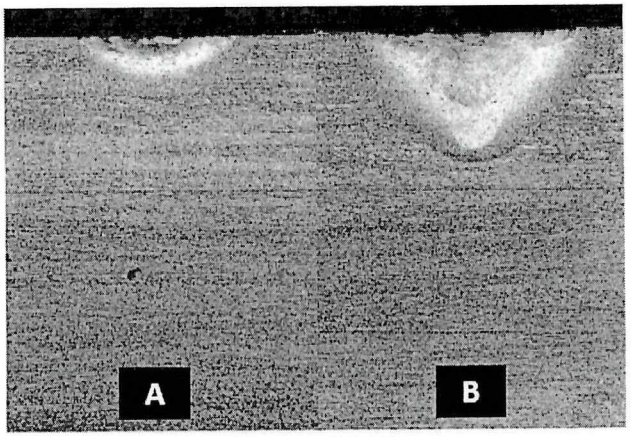

Figure Q1(d)

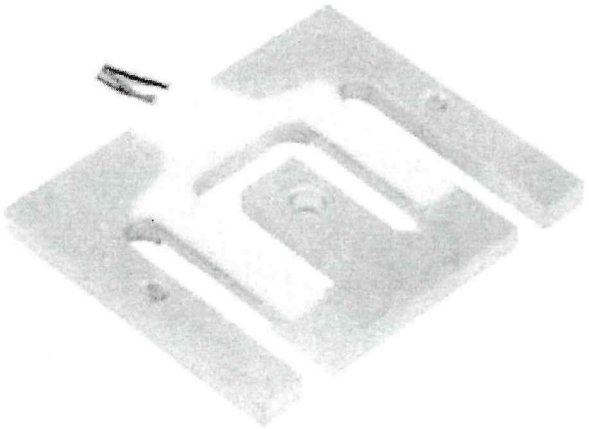

Figure Q6(c)