Department of Mechanical Engineering
IIT Kharagpur

# NONTRADITIONAL MANUFACTURING PROCESSES: MF30604

**Mid Sem: Spring 2016-17 Time: 2 hours Maximum marks: 60**

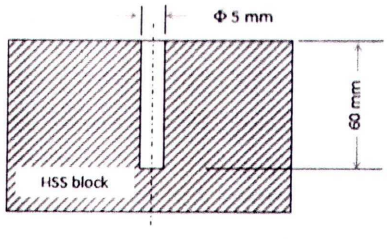
## Attempt all questions of Part-A and Part-B

## Part – A (to be answered in 1 hour 20 minutes)

**Q. 1(a)** How are the nontraditional manufacturing (NTM) processes classified based on the type of energy used in material removal? Name the major NTM processes under each category. **[2+2=4marks]**

**Q. 1(b)** In the adjacent figure, a circular blind hole of 5 mm dia. and 60 mm depth is to be drilled on a HSS block. It is required to have the diametrical accuracy is (+-) 50 micron and taper less than 0.5 degree in the hole.

State the reasons for which this task cannot be done by conventional drilling process.




**[3 marks]**

**Q. 1(c)** From your understanding of the mechanism of material removal in electric discharge machining state

(i) Why do you need a dielectric as the working medium?

(ii) Why cannot a continuous DC source be used as the power source in EDM?

(iii) Why is copper a good material for tool for EDM?

**[2+2+2=6 marks]**

**Q. 1(d)** Explain how can the inter-electrode gap in EDM be controlled through a servo control system? How is polarity of tool and job decided in EDM?

**[4+3=7 marks]**

**Q. 2(a)** For a relaxation type generator in EDM, following data is given.

Charging resistance = 100 Ohm, C = 20 micro-Farad, Supply voltage = 200 V, Breakdown voltage = 150 V, Total resistance of the discharge circuit 20 Ohm. The condenser is discharged to a voltage of 10 V during deionization.

**Calculate**

(i) Charging time before break down takes place,
(ii) Minimum charging current,
(iii) Pulse on time of the EDM machine,
(iv) Maximum discharge current, and

**[1x4 = 4 marks]**

**Q. 2(b)** In the first case of electric discharge machining (EDM) of a tungsten carbide block, a frequency 10 kHz and a duty factor of 0.7 were is used. 80% of the pulse signals were found to result in effective discharge.

In the second case of EDM-ing the same material the frequency was changed to 5 kHz and the duty factor to 0.8. In this case 90% of the pulse signals were found to result in effective discharge.

(i) What is the pulse off time for the second case?

(ii) By what percentage the MRR in the second case is expected to increase/ decrease compared to the first case? (Assume discharge energy per pulse remains unaltered.)

**[2+2=4 marks]**

**Q. 3(a)** What are the different types of masks used in chemical machining and where are they used?

**Q. 3(a)** What are the selection criteria for an etchant in chemical machining (CHM)?

**Q. 3(a)** What are the sequences of photochemical machining? Explain with diagram.

**[3+2+7=12 marks]**

## PART B (To be answered in 40 minutes)

**Q. 4** Answer the following in brief: **(Marks:4x2.5=10)**

**(a)** What make nontraditional machining (NTM) different from conventional or traditional machining? Explain giving examples of a few typical NTM Processes.

**(b)** Among high power continuous wave fiber laser, Q-switched pulsed Nd:YAG laser and high power diode laser which is preferred for cutting steel sheet and which one for drilling fine holes? Give reasons for your preferences

**(c)** What is the difference in material removal mechanisms in laser cutting and electron beam cutting of metal sheets?

**(d)** What are the factors that determine the focal spot size of electron beam in E-beam machine?

Q. 2 A Q-switched pulsed Nd:YAG laser operating at 1.06 μm wavelength has 4mm beam diameter, beam quality parameter, $M^2$ =3 and ~1 milli radian full divergence angle.
A steel sheet of 1 mm thickness is being drilled with this laser at 250 mJ pulse energy delivered in 100 ns pulse duration. The laser beam is focused on the sheet with the help of a lens of 200 mm focal length. How many laser pulses will be required to drill a through hole in the sheet and what will be diameter of the hole? You may assume that whole material is removed by vaporization in this drilling process.

**(Marks: 2.5 +2.5=5)**

Steel properties are given here below:
Absorptivity of laser radiation = 0.5, Density = 8000 kg/$m^3$, Specific heat = 500J/ kg K, Thermal conductivity = 20W/m K, Melting temperature = 1500°C, Latent heat of fusion = 300 kJ/kg, Boiling temperature =3000°C, Latent heat of vapurization = 6500kJ/kg.

**Q. 3** The specific power required for machining tungsten with E-beam is 12 W/ $mm^3$/min. A 200 micron wide slit is to be cut in a 300 micron thick tungsten sheet using an electron beam focused to 200 micron diameter spot on the sheet. The thermal diffusivity of tungsten is $6x10^{-5}$ $m^2$/s. What should be electron beam power and cutting speed so that the slit width is equal to the focused e-beam diameter?

**(Marks:2.5+2.5=5)**

*** End of question paper ***