NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

Faculty of Industrial Technology

Department of Industrial and Manufacturing Engineering

MANUFACTURING PROCESSES III -TIE 5103

1st SEMESTER EXAMINATIONS APRIL 2009

Instructions To Candidates

1.Examination length is **3hrs**.
2.Each question carries twenty **(20**) marks and there are six **(6)** questions in total.
3.Attempt the whole of Section A and any other three questions from Section B.
4.Pay attention to the instructions on the cover page of your answer booklet.

Section A

Question 1

a) Define powder metallurgy. [3]

b) Powder metallurgy is one of the routes to producing steel gears, tungsten wire, high – speed steel cutting tools, permanently lubricated bearings, and elongated single – domain magnets. For each case, give the principal reason for choosing this technique over other manufacturing techniques. [5]

c) Perfectly spherical nickel powder of 0.1 mm particle diameter is compacted by vibration. The density of nickel is 8.80 g/cm^3. What percentage of the theoretical density can be achieved? Will this increase or decrease if the particle diameter is uniformly increased to 0.2 mm? [7]

d) A cube of 25 mm sides and 95% theoretical density is to be made by metal injection moulding. The binder is 40% by volume and is completely removed during debinding and sintering. Calculate

(i) The volumetric shrinkage. [4]

(ii) Linear shrinkage. [1]

Question 2

a) Make a sketch of calendering. State what metalworking process it resembles and the products derived from this melt processing technique. [6]

b) Why is draft essential in plastic parts manufacturing? [2]

c) Polyvinyl chloride (PVC) is best processed through some particular manufacturing routes. Name them. [3]

d) Some injection-moulded parts are observed to warp soon after manufacture. What could be the potential causes? [3]

e) A material – tool combination follows the Taylor tool – life relationship of:

$$VT^{0.3} = 300 \text{ m/min.}$$

(i) If the cutting speed is increased by 20%, what is the percentage decrease in tool life? [3]

(ii) If the exponent is decreased from 0.3 to 0.1 and the cutting speed is increased by 20%, what is the percentage decrease in tool life? [3]

Section B

Question 3

a) Why is machining unique? [2]

b) Distinguish between turning and milling. [3]

c) A steel is cut on a lathe with HSS tooling. It is now proposed to increase production rates by 30%. There is debate whether increased production should be obtained with increased speed, feed, or depth of cut. Settle the argument and recommend which variable should be increased first and which one last. [5]

d) An end mill is used to put a 30 mm slot with a depth of 7 mm in a grey cast iron block. The block is 60 mm wide x 13 mm high x 150 mm long. The cutter, a high-speed cutter with a radius of 15 mm, has six teeth. The pretravel and overtravel combine to a total length of 8 mm. The cut will be made at a feed rate of 0.150 mm/tooth and a cutting speed of 50 m/min. The unit kilowatt power is 0.010 $kW/mm^3/min$.

(i) What is the RPM used? [2]

(ii) What is the length of the lead? [1]

(iii) What is the cutting time? [3]

(iv) What is the metal removal rate? [2]

(v) What is the power (kW) required at the cutter? [2]

Question 4

a) Explain why porosity

(i) Impairs the mechanical properties of powder metallurgy parts. [3]

(ii) Impairs tensile and impact properties more than compressive strength or hardness. [3]

b) A powder metallurgy part is to be made from the following materials. The final part will be only 95% dense and have a total volume of 12 cm^3. The void spaces will be used for oil impregnation. The material information is given below.

Material	Density (g/cm^3)	Weight (%)	Tensile Strength (MPa)	Cost ($/kg)
A	8.80	30	200	10.00
B	6.20	60	150	8.00
C	5.50	10	90	7.00

(i) Determine the weight of each of the components to be mixed and the total weight. [8]

(ii) Estimate the tensile strength of the part if the properties vary according to the volume fraction. [4]

(iii) Determine the material cost of the sintered part. [2]

Question 5

a) Define the following:

(i) Die swell [2]

(ii) Parison [2]

(iii) Thermoforming [2]

(iv) Compression ratio [2]

(v) Drag flow [2]

b) A round bar of 15 mm diameter is extruded from a single – screw extruder of 100 mm diameter. The material is LDPE with a relative density of unity and a specific heat capacity of 2.3 kJ/kg. K. Calculate the

(i) Approximate flow rate [2]

(ii) Speed of emerging extrusion [4]

(iii) Expected power requirement [2]

(iv) Temperature rise [2]

Question 6

a) What are the two types of metal – cutting models used in analysing forces? [2]

b) Chips are found to clog up the machining space. Identify the possible causes of the problem. Suggest remedies when cutting (1) ductile and (2) less – ductile materials. [4]

c) List the two functions of cutting fluids at low cutting speeds. [2]

d) A 25 mm diameter bar, 150 mm in length, is to be finish turned with a depth of cut of 0.125 mm at a cutting speed of 60 m/min. The length of pretravel and overtravel is 6.25 mm, the unit kilowatt power is 0.05 kW/mm^3/min, the tare power is 224 kW, the motor efficiency is 80%, and the feed rate used is 0.25 mm/rev. Calculate

(i) RPM used. [2]

(ii) Power requirements at the cutter. [4]

(iii) Power required by the motor. [3]

(iv) Cutting time. [3]

End of Examination