A

Department of Mechanical Engineering
Indian Institute of Technology Kanpur

TA – 202: Manufacturing Processes

End Sem. Exam.

VKJ/2014/SI; Time: 180 min; Max. Marks: 180

NOTES:

(I) Answer all questions in the space provided in the question paper itself.
(II) Answers should be brief, to-the-point and can be supplemented with neat sketches, if necessary.
(III) Figures on the right-hand side within parentheses indicate full marks.
(IV) No clarification is encouraged.
(V) Your signature on pledge is mandatory.

NAME ……………………………................. **ROLL NO.** ………………………………

SECTION ……………………………….(Mon/Tue/Wed/Thu/Fri)

PROJECT GROUP NO. ………………………… **SUBJECT** …………………………

DATE ……………………………..

FOR EXAMINER ONLY

QUESTION NO.	MARKS
Q-1	
Q-2	
Q-3	
Q-4	
Total	

I PLEDGE MY HONOR AS A GENTLEMAN/LADY THAT DURING THE EXAMINATION I HAVE NEITHER GIVEN ASSISTANCE NOR RECEIVED ASSISTANCE.

……………………………
Signature

Q.1. (A) Encircle the most appropriate answer(s). **[1.5 X 8]**

(I) With a tungsten carbide cutting tool, highest cutting speed can be used while machining: (a) stainless steel, (b) Mild Steel, (c) aluminum, (d) brass.

(II) Material removal in ECM process is by: (a) ionization and shearing, (b) transfer of electrons, (c) chemical action and abrasion, (d) migration of ions from anode and forming sludge, (e) none of these.

(III) Write the type of chips produced during turning of cast iron: (a) Continuous, (b) continuous with BUE, (c) discontinuous, (d) none of these.

(IV) The mechanism of metal removal in Electric Discharge Machining is (a) brittle fracture, (b) shear deformation, (c) anodic dissolution, (d) melting and vaporization, (e) none of these.

(V) The machining action in Ultrasonic Machining is achieved by: (a) impact of tool on workpiece, (b) impact of tool on abrasive particles, (c) impact of tool on the coolant, (d) none of these.

(VI) Machinability in metal cutting depends on : (a) tool life, (b) tool material properties, (c) workpiece material properties, (d)all of the these.

(VII) Negative rake angle on the cutting tool is provided for: (a) reducing cutting forces, (b) improving dimensional accuracy, (c) strengthening cutting tool, (d) improving surface finish.

(VIII) Tungsten carbide bar of 30 mm diam. is to be turned on a lathe machine. Which tool material will you recommend? (a) HSS, (b) WC, (c) alloy steel, (d) none of these.

(B) Give **four** important reasons for "Why advanced machining processes are needed? Or under what circumstances you need to use AMPs?" **[4 x 1.5]**

<u>**Answer**</u>**: (1).**

(2).

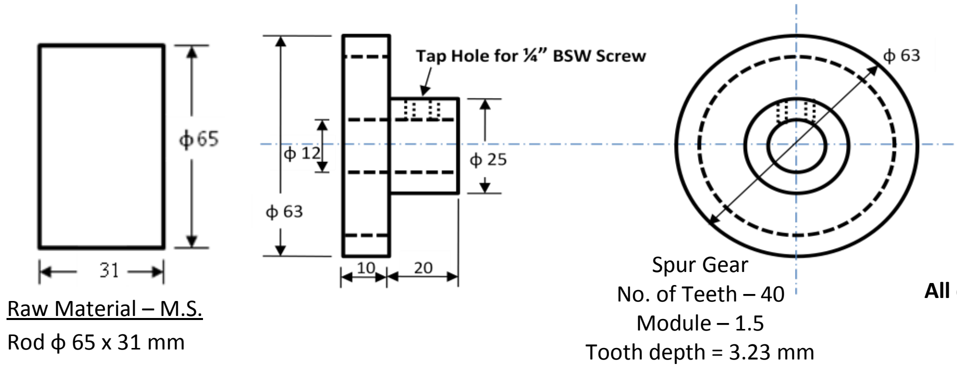
(3).

(4).

(C) A mild steel workpiece of 120 mm diameter is to be turned using HSS tool. Some of the spindle speeds available on the lathe machine are 90, 114, 155, 200, 250, 320, 400 and 500 RPM. The tool life exponent of the Taylor's tool life equation is 0.6 and the value of the machining constant is 700. What is the highest spindle speed that the operator should choose for 60 minutes tool life (Hint: Take cutting speed in m/min and tool life in min.***)***? **[6]**

<u>**Solution**</u>**:**

(D) Write the sequence of operations that should be followed to make the following spur gear, Fig. 1 (Also, write the type of tool and the thickness of the material being removed). **[12]**



All dimensions are in mm

Fig.1

<u>Solution</u>:

(E) To make M10 threads in the given M.S. plate, select proper drill size and order of taps to be used for threading purposes. Available drills – 6.5, 7.9, 8.5, 9.5, 10 mm. **[4]**

<u>Solution</u>:

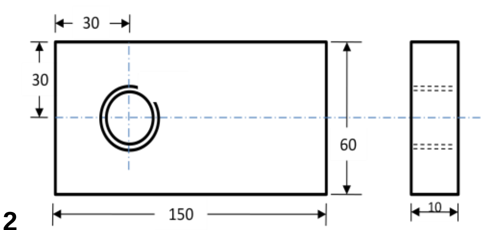


Fig. 2

(F) A single point cutting tool is used with a chip breaker. How does a chip breaker help in producing good surface quality of the product? Will you recommend the use of a chip breaker while turning Cast Iron? Justify your answer. **[5]**

<u>Solution</u>:

Q. 2. (A) Match items of column A with items of column B. More than one answer may be correct. Write answers in the space provided below. **[1.0 x 20]**

A	B
(a_1) Drilling of cooling holes in a turbine blade(1.5 mm Φ, 100 mm length)	(b_1) Economic health of a country
(a_2) Writing your name on a human hair.	(b_2) EDM
(a_3) Pico second	(b_3) ECM
(a_4) Metal cutting tool fails	(b_4) Hole diam. > Shaft diam.
(a_5) Tungsten carbide	(b_5) Machining of ceramics
(a_6) I^2Rt = heat produced	(b_6) FIB deposition
(a_7) Nano spring fabrication	(b_7) FIB Machining
(a_8) Ultrasonic machining	(b_8) EBM
(a_9) Manufacturing activity relates to	(b_9) LBM
(a_{10}) NaCl electrolyte	(b_{10}) Plastic deformation
(a_{11}) Kerosene oil	(b_{11}) Tool cathode and workpiece anode
(a_{12}) Making of turbulated holes in a turbine blade	(b_{12}) AWJM
(a_{13}) Ignition delay time	(b_{13}) WJM
(a_{14}) Normal polarity	(b_{14}) $1*10^{-12}$ second
(a_{15}) Machining done under vacuum	(b_{15}) None of these
(a_{16}) Striated surface	(b_{16}) Tool material
(a_{17}) Atom by atom material removal	
(a_{18}) Force fit	
(a_{19}) Cutting of wood	
(a_{20}) Cutting of concrete	

Answer:

(a_1) , (a_2) , (a_3) , (a_4) , (a_5) , (a_6) , (a_7) , (a_8) , (a_9) , (a_{10}) , (a_{11}) , (a_{12}) , (a_{13}) , (a_{14}) , (a_{15}) , (a_{16}) , (a_{17}) , (a_{18}) , (a_{19}) , (a_{20}) .

(B). Name the cutter and size of cutter to produce a slot in the given square bar? **[3]**

Solution:

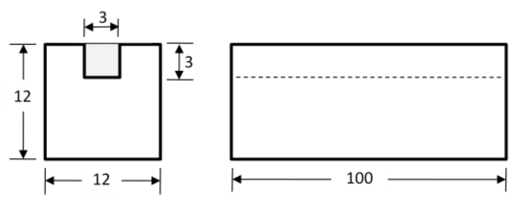


Fig.3

(C) Draw Merchant's force circle diagram and show the following. **[6 + 2 + 2]**

(i) All the six forces along with the directions and the resultant force.

(ii) Tool, workpiece, chip.

(iii) Rake angle, clearance angle, shear plane angle and friction angle.

Solution:

(D) Derive the following equation to calculate linear material removal rate (MRR_l) in ECM using Faraday's laws of electrolysis. Write the assumptions made if any, and draw the neat sketch if required. **[12]**

$$MRR_l = \frac{(V-\Delta V)kE}{yF\rho_a}$$

where, ρ_a = density of anode, A_a = cross sectional area on the anode from which material is being removed in time 't', y = distance between the tool and workpiece being machined. ΔV is over potential, k= electrolyte's electrical conductivity, E = Electrochemical equivalent (g), V = applied voltage, F = Faraday's constant, V_a = Volume of workpiece removed, I = Current.

<u>Solution</u>:

Q. 3. (A) Encircle the most appropriate answer(s): **[1.5 x 4]**

(i). Turbine blade can be finished to nanometer Ra value by (a) AFM process, (b) ECM, (c) IBM, (d) None of these.

(ii). The continuous chip with BUE: (c_1) yields good surface finish, (c_2) yields poor surface finish, (c_3) has no effect on surface roughness.

(iii). Many thousand holes (diameter = 50 µm) per centimeter square are to be drilled at a high drilling rate (a few microseconds per hole). Which process will you recommend: (a_1) EDM, (a_2) ECM,(a_3) EBM, (a_4) USM.

(iv). There are two holes A and B each of 2 mm diameter, and 100 mm deep made in a M.S. block. These holes are separated by a thin wall of about 1 mm thickness. One hole is to be made across the wall to join the holes A and B, at a distance of 40 mm from the top surface. Which process will you recommend?: (a_1) EDM, (a_2) ECM, (a_3) EBM, (a_4) LBM.

(B) Find out least count of a Vernier Height Gauge with the following details: **[3]**
(Show all calculations you make)
One small division on main scale = 1 mm; No. of divisions on Vernier scale = 50; Vernier scale 50 divisions = 49 small divisions on main scale (or 49 mm). *(Zero mark for answer without calculation)*

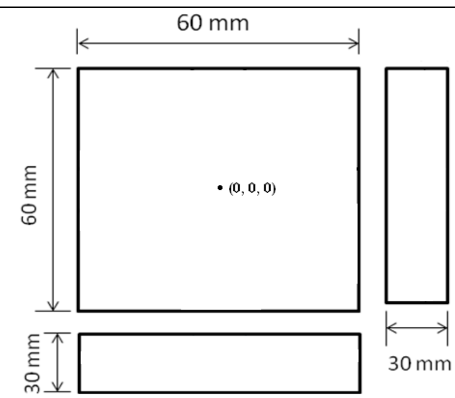
Solution:

(C) For the following NC part program, draw the part that will get made. Sketch the feature made and write the dimensions of the feature made. Take initial part size as 60 x 60 x 30 mm and center as 0, 0, 0 (Figure). (Hint: Complete all the three views of the figure given below as a machined component.) **[12]**

O0001				
N5	G90	T09	M06;	
N10	G94	S1000	F100	M03;
N15	G00	X-40	Y0	Z10;
N20	G01	Z-3.0;		
N25	X40;			
N30	G00	Z10;		
N35	G00	X0	Y40;	
N40	G01	Z-3.0;		
N45	Y-40;			
N50	G00	Z10;		
N55	M05;			
N60	M30;			

1. End mill cutter dia. 10 mm.

Solution:



Note: G00 – Rapid Traverse; G01 – Linear interpolation; G94 – Starts rotation; G90 – Absolute dimensions; M06 – Tool change; M03 – Clock wise rotation; M05 – Spindle stops; M30 – m/c stops

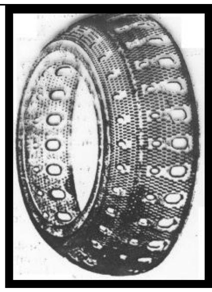
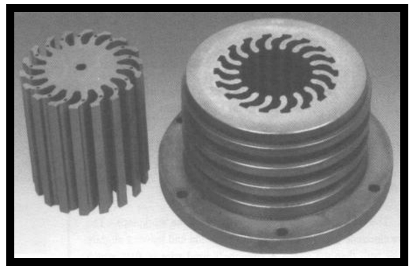
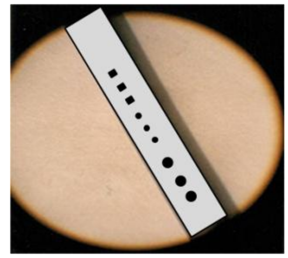
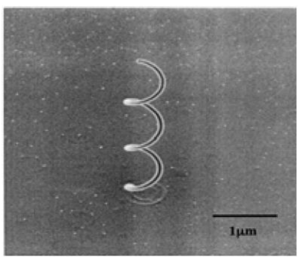
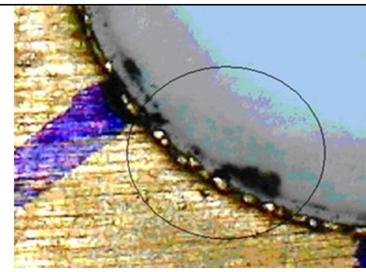
(D) (i) Mild steel is being machined at a cutting speed of 200 m/min with a tool rake angle of 10^o. The width of cut and uncut chip thickness are 2 mm and 0.2mm, respectively. If the average value of coefficient of friction between the tool and chip is 0.5 and the shear stress of the work material is $400 N/mm^2$. Determine: cutting and thrust components of machining force. Assume $\Phi + \beta - \alpha = (\pi/4)$. {$\Phi$ = Shear angle, β = Friction angle, α = Rake angle} **[14]**

Solution:

(ii) Draw a schematic diagram of ECM process showing all the essential elements: tool, workpiece, power supply, polarity, IEG, range of electrolyte velocity. If iron is being machined, write the expected chemical reactions and clearly write what will form as the sludge? Neutral salt (NaCl) is used as an electrolyte. **[10]**

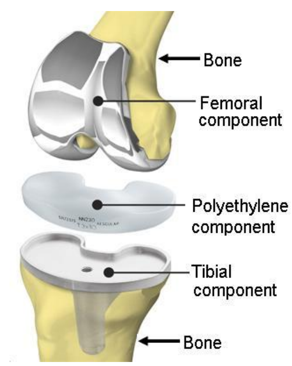
Solution:

Q. 4. (A) Suggest the most appropriate process for economical fabrication of the following parts. Use the given rectangular space for writing answer. **[1.5 x 6]**

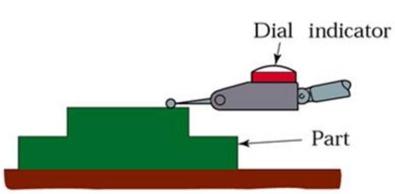
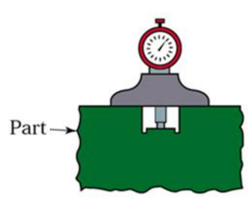
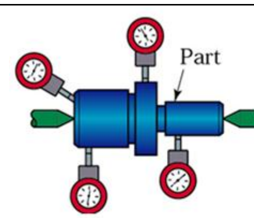
 (a) Thousands of holes in a helicopter component made of a thin metal sheet.	 (b) Both Male and female metal parts made from one single cylindrical piece.	 (c) Circular and rectangular μ – holes made in difficult-to-machine metallic part.
(a)	**(b)**	**(c)**
 (d) Nano spring (please see scale)	 (e) Micro wine glass with total height < 100 μm.	 (f) Micro burrs to be removed from the edge of micro holes.
(d)	**(e)**	**(f)**

(B) (i). Write the name of a method for nano-finishing femoral component as shown below. **[1.5]**

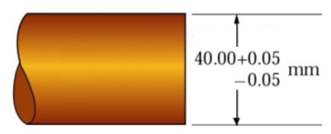
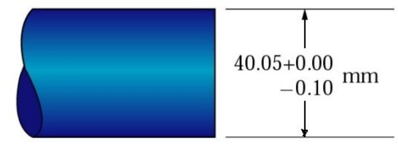
<u>Solution:</u>



(ii). Name the type of the operation being performed in the figures given below. **[1.5 x 3]**

 (a)	 (b)	 (c)
(a)	**(b)**	**(c)**

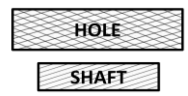
(C) Write the type of tolerances (Unilateral or bilateral) in (a) and (b), and find limit dimensions. **[1 x 3]**

		**Limit dimensions for parts:** **(a)** **(b)**
(a)	(b)	

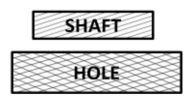
(D) (i). Write maximum and minimum clearance / interference (whichever is applicable) using proper arrows in the figures given below. **[4]**

Figure:

(I)



(II)



(E) What is the expected value of R_{max} for the details given in the figure? Assume any data if required, but write it clearly. **[4]**

Solution:

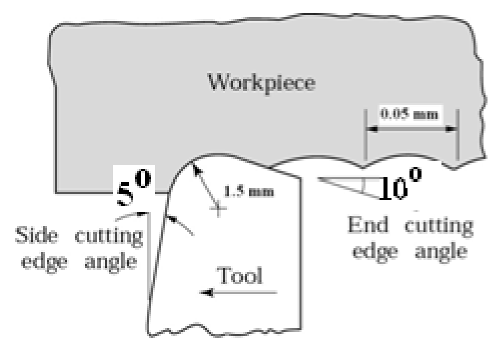


Fig.3

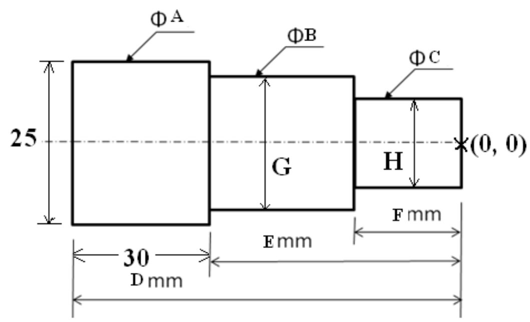
(F) Draw a figure showing various elements of flank wear and crater wear. **[3]**

Solution:

(G) From the following program and the part made, determine the value of A, B, C, D, E, F, G, H. **[12]**

O0002					
N5	T0101				
N10	G90	G95	S1000	F0.2	M04;
N15	G00	X26	Z2.0;		
N20	G01	Z-1.0;			
N25	X-1.0;				
N30	G00	X26	Z0;		
N35	G01	X23;			
N40	Z-35.0;				
N45	G00	X24	Z0;		
N50	G01	X20;			
N55	Z-15;				
N60	G00	X50	Z50;		
N65	M05;				
N70	M30;				

Solution:



All dimensions are in mm

Note: G00 – Rapid Traverse; G01 – Linear interpolation; G94 – Starts rotation; G90 – Absolute dimensions; M06 – Tool change; M03 – Clock wise rotation; M05 – Spindle stops; M30 – m/c stops

(H) An orthogonal cutting operation is being carried out under the following conditions: cutting speed = 2 m/s, feed = 0.5 mm per revolution, chip thickness = 0.6 mm. Draw a velocity diagram for orthogonal cutting and find the chip velocity. **[4]**

Good Luck