CMR
INSTITUTE OF
TECHNOLOGY

USN | | | | | | | | | | |

Internal Assesment Test - III

Sub:	Machine Tools & Operations							Code:	15ME45B
Date:	22 / 05 / 2018	Duration:	90 mins	Max Marks:	50	Sem:	IV	Branch:	MECH (A & B)

Answer Any FIVE full Questions

			Marks	OBE	
				CO	RBT
1		Using Merchant's circle diagram, derive the equation $2\Phi+\beta-\alpha=\pi/2$	[10]	CO5	L4
2		Briefly explain the process parameters that influence tool life.	[10]	CO5	L4
3		Explain with neat sketches the different types of chips formed during metal cutting process.	[10]	CO4	L4
4	A)	List the differences between orthogonal cutting and oblique cutting.	[6]	CO4	L1
	B)	Explain with neat sketches the different tool wear mechanisms.	[4]	CO5	L1
5		The following data were obtained during orthogonal turning of a certain workpiece material. Chip thickness = 0.45mm, width of cut = 2.5mm, feed = 0.25mm/rev, cutting force = 113kg, thrust force = 29.5kg. The cutting speed was 150m/min and the rake angle was +10°. Calculate the following :- a) Chip thickness ratio, b) Chip reduction co-efficient, c) Shear angle, d)Velocity of chip along the tool face, e) Frictional force along the tool face, f) Shear stress, g) Power required for cutting.	[10]	CO4	L3
6		The tool life for HSS tool is expressed by the relation $VT^{1/7}=C_1$ and for Tungsten carbide tool it is $VT^{1/5}=C_2$. If the tool life for a cutting speed of 24m/min is 128 min, compare the life of the two tools at a speed of 30 m/min.	[10]	CO5	L3

Machine Tools & Operations
Internal Assessment - III
Scheme & Solution

Q.No.	Description	Marks
1)	Merchant analysis diagram	2
	Shear Stress $\tau = F_s A_s = \frac{F_s A_0}{\sin\phi}$	4.
	$2\phi + \beta - \alpha = \frac{\pi}{2}$	4.
2)	Parameters influencing tool life	
	1) Cutting conditions →	2
	2) Tool geometry →	2
	3) Tool material →	2
	4) Work material →	2
	5) Condition of the tool work interface →	2.
3)	Types of Chips formation.	
	1) Continious chip →	2
	diagram →	2
	2) Dis-continious →	2
	diagram →	1
	3) Continious chip with build up edges →	2
	diagram →	1

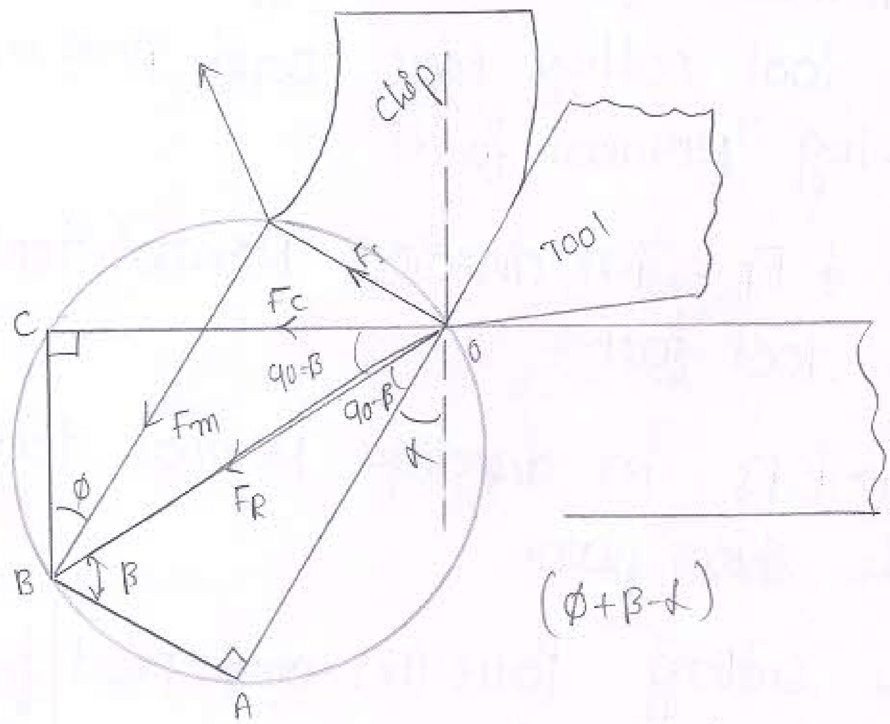
4)		
A)	Answer any 6 difference between Orthogonal & Oblique cutting process	6.
	* Each carry 1 marks	
B)	<u>Tool wear mechanisms</u>	
	1) Adhesive wear →	1
	2) Abrasive wear →	1
	3) Diffusion wear →	1
	4) Chemical wear →	1
5)	$r = 0.555$ →	1/2
	$K = 1.801$ →	1/2
	$\phi = 30.674^\circ$ →	1
	$V_s = 83.25$ m/min →	2
	$F_f = 477.48$ N →	2
	$\tau = 657.836$ N/mm^2 →	2
	$P = 2.77$ kW →	2
6)	$C_1 = 48$ →	2
	$C_2 = 63.33$ →	2
	$T_1 = 26.84$ min →	2
	$T_2 = 41.9$ min →	2
	Ratio $= \frac{T_1}{T_2} = 0.64$ →	2

MTO = Internal Assessment - III

Solution

Date: 26/05/2016.

(1) Using Merchant's circle diagram. derive the equation $2\phi+\beta-\alpha = \pi/2$.



Ernst and Merchant presented analysis is first complete chip analysis termed as shear angle solution consider. the chip formation problem in an other orthogonal cutting S/m as shown in figure.

In orthogonal system the following terms are used.

α = Rack angle

ϕ = shear angle

β = Friction angle on the tool

T_1 = Thickness of chip before cutting

T_2 = Thickness of chip After cutting.

F_s = Shear force on shear plane

F_R = Resultant tool post

F_c = cutting force

F_t = Thrust force.

Now Resultant force (F_R) being considered to act at the tool cutting edge. and Resolved the following Normal forces.

(i) F_N & F_F in direction Normal tool and along the tool face

(ii) F_{ns} & F_s in direction Normal tool and along the shear plane

(iii) The cutting force (F_c) and Trust force (F_t) in direction normal tool and along the tool moment.

In the ~~otor~~ analysis. Ernst and Merchant assumed that the Resultant tool force was utilized in the Metal cutting operation and effect of other frictional forces was negligible. and also assume that value of shear angle was such that workdone in cutting was minimum.

$F_c = F_s \cos\phi + F_{ns} \sin\phi$

$F_t = F_{ns} \cos\phi - F_s \sin\phi$

$F_f = F_c \sin\alpha + F_t \cos\alpha$

$F_n = F_c \cos\alpha - F_t \sin\alpha$

$F_s = F_c \cos\phi - F_t \sin\phi$

$F_{ns} = F_c \sin\phi - F_t \cos\phi$

$\therefore \quad F_c = F_R \cos(\beta - \alpha)$

$$\therefore \quad F_R = \frac{F_c}{\cos(\beta-\alpha)} \quad \text{—— (i)}$$

$F_s = F_R \cos(\phi + \beta - \alpha)$

$$F_R = \frac{F_s}{\cos(\phi+\beta-\alpha)} \quad \text{—— (ii)}$$

$$\mu = F_t / F_n = \frac{F_c \sin\alpha + F_t \cos\alpha}{F_c \cos\alpha - F_t \sin\alpha} \quad \text{—— (iii)}$$

From equation ① & ②

$$\frac{F_c}{\cos(\beta-\alpha)} = \frac{F_s}{\cos(\phi+\beta-\alpha)}$$

$$F_c = \frac{F_s \cos(\beta-\alpha)}{\cos(\phi+\beta-\alpha)} \quad \text{—— (iv)}$$

we know that Max^m shear force

$$\tau_n = F_s / A_s \quad \text{—— (v)}$$

$$A_s = \frac{A_0}{\sin\phi} = \frac{b_1 t_1}{\sin\phi} \quad \text{—— (vi)}$$

$$\tau_m = \frac{F_s \sin\phi}{A_0}$$

$$F_s = \frac{\tau_m A_0}{\sin\phi} \quad \text{—— (vii)}$$

Substitute equation (7) in (4)

$$F_c = \frac{\tau_m A_o}{\sin\phi} \frac{\cos(\beta-\alpha)}{\cos(\phi+\beta-\alpha)} \quad \text{———— (viii)}$$

According to Ernst and Merchant Angle ϕ That value which is Required minimum force to the Merchant. considering A_o & shear force of independent of shear angle.

differentiate equation (8) with respect to shear angle and equating to zero.

It becomes

$$2\phi + \beta - \alpha = \pi/2$$

---

(2) Briefly Explain the process parameters that influence tool life.

Tool life is affected by the following parameters

(i) cutting conditions

(ii) Tool geometry

(iii) Tool material

(iv) work material

(v) condition of the tool work interface.

* The cutting condition are Related by the equation $VT^n f^m d' = C$. where $1, m \& n$ constants depend on tool and work materials.

Orientation: The Rake angle decreases the cutting forces and hence decrease in heat produced. This Results is increased tool life. But the value of Rake angle must not be increased too much as it Results in Reduced tool material for heat conduction

* carbide tool have higher tool life than HSS for the identical conditions of machining.

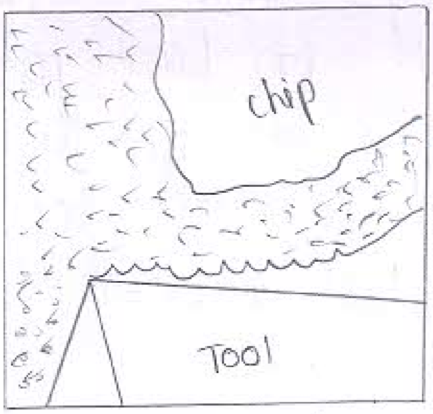
* Hardness, microstructure and different phases influence tool life, work material having soft phases like ferrite in steel form BUE and Results in poor Surface finish. Cast iron having graphite phase enhances tool life.

* Dry condition increases temperature of the tool and Reduces tool life. use of cutting fluid provides lubrication and carries away heat as well.

(3) Explain with neat sketches the different types of chips formed during metal cutting process.

The chips formed during cutting may be of the following types

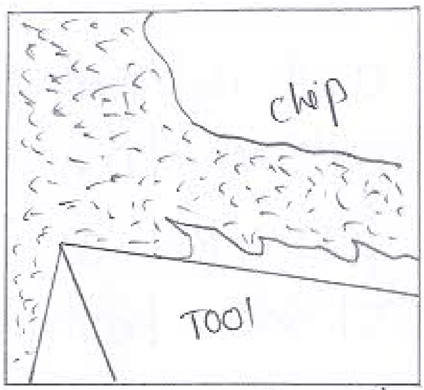
(i) <u>continuous chip</u>: This type of chip is formed commonly in all ductile materials such as wrought iron, mild steel, Aluminium and copper.



Continuous chip

The formation of the chip takes place in the zone extending from the tool cutting edge to the junction between the surfaces of the chip and work piece. The zone is known the primary deformation zone.

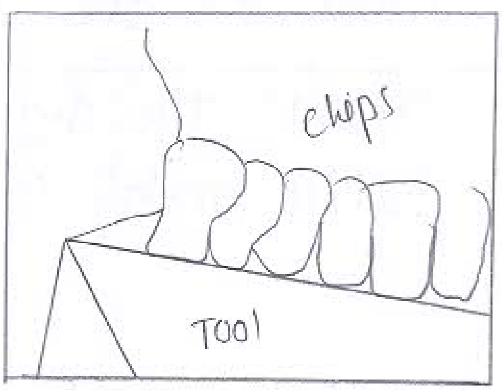
(ii) Continuous chip with built up edges (BUE)



Continuous chip with built up edges.

Under certain conditions the friction between the chip and the tool is so great that the chip material welds itself to the tool surface. due to the presence of this welded metal there will be further increase in friction. This Results in building up of layer upon layer of chip material.

(iii) Discontinuous chip :



Discontinuous chip

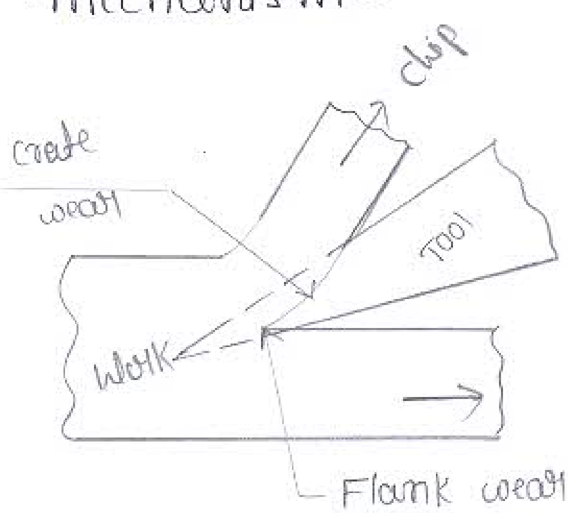
While the chip is being formed severe strain is set up and If the work piece is brittle, fracture will occur in the primary deformation zone when the chip is only partly formed. The chip is segmented and the condition is Refered to as discontinuous chip formation.

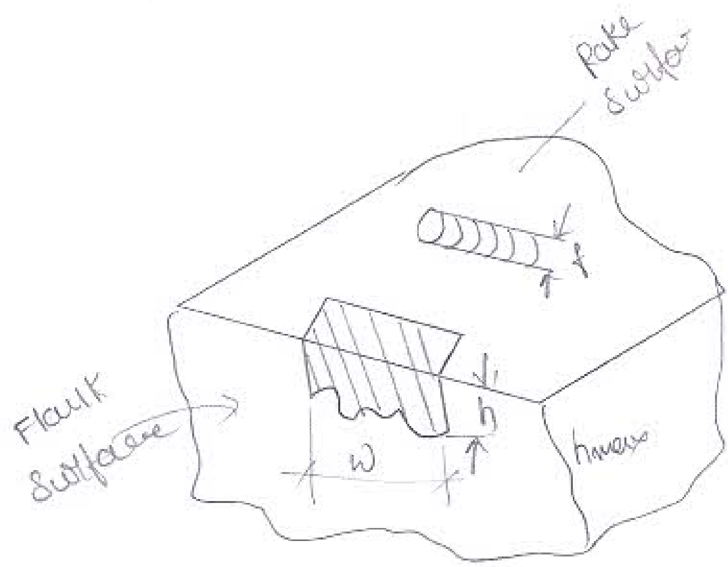
(4)

(A) List the differences between orthogonal cutting and oblique cutting.

Orthogonal cutting	Oblique cutting.
(i) cutting edge of the tool is perpendicular to the direction of the velocity vector	(i) cutting edge of the tool makes an angle with the normal to the cutting velocity vector.
(ii) The chip formed flows on the Rake face of the tool with chip velocity perpendicular to the cutting edge	(ii) The chip formed flows on the Rake angle face of the tool at an angle with the normal to the cutting edge in the plane of the face
(iii) The cutting forces act along X & Z directions only.	(iii) The cutting forces act along all the three directions Y and Z.

(B) Explain ~~thith~~ neat sketches the different types ~~of chips formed during metal~~ tool wear mechanisms.





Wear take place on the surface along which there is sliding action. In the case of a cutting tool, the wear takes place on the Rake surface where the chip flows over the tool and on the flank surface where Rubbing action b/w work and tool occurs.

These wear are the called as the crater wear and Flank wear. During wear process. Abrasion wear. Adhesion wear and diffusion wear mechanisms will be active depending on various conditions.

Abrasion and Adhesion wear as primarily Responsible for the flank wear.

Diffusion wear may play an important Role in crater wear at a high speed

Flank wear is a worn surface below the cutting edge. Flank wear takes place when machining brittle materials like cast iron or when feed is less than 0.15 mm/rev. h_l = width of wear land of wear

h_f = ht of wear of flank h_{max} = max. ht of flank wear.

crater wear occurs in the form of a depression on the Rake surface due to pressure of the chip on the Rake during sliding.

(5) The following data were obtained during orthogonal turning of a certain workpiece material. chip thickness = 0.45 mm. width of cut = 2.5 mm feed = 0.25 mm/rev. cutting material force = 113 kg. Thrust force = 29.5 kg. The cutting speed was 150 m/min and the Rake angle was $+10^\circ$. calculate the following

(a) Chip thickness Ratio, (b) Chip Reduction co-efficient.
(c) shear angle (d) Velocity of chip along the tool face
(e) Frictional force along the tool face. (f) shear stress
(g) power Required for cutting.

<u>Soln</u>

Given data.

$t_2 = 0.45\ mm$

$b_1 = 2.5\ mm$

$f = t_1 = 0.25\ mm/rev$

$F_c = 113\ Kg = 1108.53\ N$

$F_t = 29.5\ Kg = 289.395\ N$

$V_c = 150\ m/min$

$\alpha = 10^\circ$

(a) Chipthickness Ratio $= r = \frac{t_1}{t_2} = \frac{0.25}{0.45} \Rightarrow \underline{\underline{0.555}}$

(b) Chip Reduction coef^{nt} $= K = 1/r = \underline{\underline{1.801}}$

(c) Shear angle

$$\phi = \tan^{-1}\left(\frac{r\cos\alpha}{1 - r\sin\alpha}\right) = \tan^{-1}\left(\frac{0.55\cos 10}{1 - 0.55\sin 10}\right)$$

$$\underline{\underline{\phi = 30.674^\circ}}$$

(d) Velocity of chip

$$V_s = rV_c \Rightarrow 0.55(150)$$

$$V_s = \underline{\underline{83.25\ m/min}}$$

(e) Frictional force along tool face

$$F_f = F_c\sin\alpha + F_t\cos\alpha$$

$$\underline{\underline{F_f = 477.48N}}$$

(f) Shear stress

$\tau = F_s / A_1$

$F_s = F_c \cos\phi - F_t \sin\phi$

$= 1108.53 (\cos 30.67) - 289.395 \sin 30.67$

$F_s = 805.85 \text{ N}$

$A_1 = \frac{A_0}{\sin\phi} = \frac{b_1 t_1}{\sin\phi} = \frac{2.5 (0.25)}{\sin(30.67)}$

$A_1 = 1.225 \text{ mm}^2$

$\tau = \frac{805.85}{1.225} \Rightarrow 657.836 \text{ N/mm}^2$

(g) power Required

$P = \frac{V_c F_c}{60000} \text{ kW}$

$= \frac{150(1108.53)}{60000}$

$P = 2.77 \text{ kW}$

(6) The tool life for HSS tool is expressed by the Relation $VT^{1/7} = C_1$ and for Tungsten carbide tool it is $VT^{1/5} = C_2$. If the tool life for a cutting Speed of 24 m/min is 128 min. Compare the life of the two tools at a Speed of 30 m/min.

Sol

Data given

HSS tool = $VT^{1/7} = C_1$

Tungsten carbide tool ⇒ $VT^{1/5} = C_2$

$V_1 = 24$ m/min , $T_1 = 128$ min

$V_2 = 30$ m/min $T_2 = ?$

For HSS tool,

$$V_1 T_1^{1/7} = V_2 T_2^{1/7}$$

$$24 (128)^{1/7} = 30 (T_2^{1/7})$$

$$T_2 = 26.843 \text{ mins}$$

For Tungsten carbide tool

$$V_1 T_1^{1/5} = V_2 T_2^{1/5}$$

$$24 (128)^{1/5} = 30 T_2^{1/5}$$

$$T_2 = 41.943 \text{ mins}$$