IE-352
Section 1, CRN: 48700/1/2
Section 2, CRN: 48706/7/8
Second Semester 1435-36 H (Spring-2015) – 4(4,1,2)
"MANUFACTURING PROCESSES – 2"

Thursday, April 23, 2015 (04/07/1436H)

MIDTERM 2 [10 POINTS]

Name:	**Student Number:** 4	**Section:** 10 / 11

Place the correct letter in the box at the right of each question [$\frac{1}{2}$ Point Each]

1. ***Classify*, respectively, the following geometric symbols: // , ⌯ , —:** ☐

   A. orientation, form, location

   B. form, orientation, location

   C. orientation, location, form

   D. location, form, orientation

   E. location, orientation, form

2. **Respectively, the following geometric symbols: // , ⌯ , — stand for,** ☐

   A. parallelism, symmetry, straightness

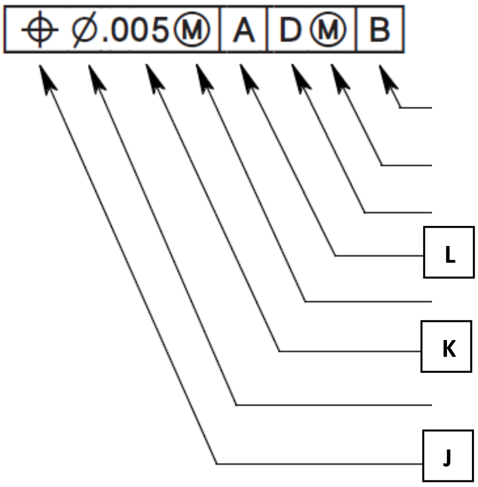
   B. symmetry, parallelism, straightness

   C. parallelism, symmetry, flatness

   D. symmetry, parallelism, flatness

   E. flatness, symmetry, straightness

Questions 3-4. Examine the feature control frame shown below and answer the questions to follow.



3. **How do you read the feature control frame shown above?** ☐

   A. position GT of feature (RFS) is 0.005-diam. cylind. zone relative to datums A, D, B

   B. circularity GT of feature (RFS) is 0.005-diam. cylind. zone relative to datums A, D, B

   C. position GT of feature at LMC is 0.005-diam. cylind. zone relative to datums A, D, B

   D. circularity GT of feature at MMC is 0.005-diam. cylind. zone relative to datums A, D, B

   E. position GT of feature at MMC is 0.005-diam. cylind. zone relative to datums A, D, B

4. **Respectively, the symbols $\boldsymbol{J}$, $\boldsymbol{K}$, and $\boldsymbol{L}$ stand for,** ☐

   A. $\boldsymbol{J}$: geometric characteristic symbol, $\boldsymbol{K}$: geometric tolerance, $\boldsymbol{L}$: tertiary datum

   B. $\boldsymbol{J}$: geometric characteristic symbol, $\boldsymbol{K}$: basic size, $\boldsymbol{L}$: primary datum

   C. $\boldsymbol{J}$: diameter symbol, $\boldsymbol{K}$: geometric tolerance, $\boldsymbol{L}$: primary datum

   D. $\boldsymbol{J}$: geometric characteristic symbol, $\boldsymbol{K}$: geometric tolerance, $\boldsymbol{L}$: primary datum

   E. $\boldsymbol{J}$: diameter symbol, $\boldsymbol{K}$: basic size, $\boldsymbol{L}$: tertiary datum

5. **For the system shown below, $\boldsymbol{GT_{LMC}} =$** ☐

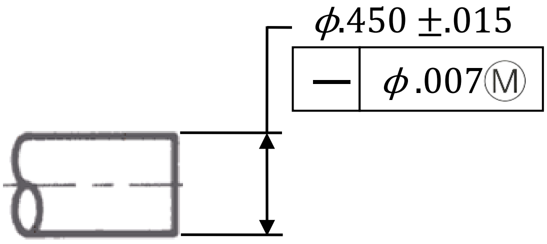
   A. 0.037

   B. 0.007

   C. 0.015

   D. 0.014

   E. 0.030



6. **Repeat P5 above given *no* material condition**

   modifier is defined in the $\boldsymbol{FCF}$. ☐

   A. 0.037

   B. 0.007

   C. 0.015

   D. 0.014

   E. 0.030

7. **The following process involves a rotating workpiece and radially inward tool:** ☐

   A. cutting off

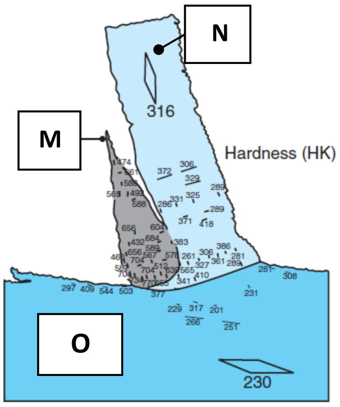
   B. slab milling

   C. drilling

   D. end milling

   E. turning

8. **Label the hardness distribution diagram shown below.** ☐



   A. $\boldsymbol{M}$: BUE; $\boldsymbol{N}$: continuous chip; $\boldsymbol{O}$: tool

   B. $\boldsymbol{M}$: continuous chip; $\boldsymbol{N}$: BUE; $\boldsymbol{O}$: tool

   C. $\boldsymbol{M}$: BUE; $\boldsymbol{N}$: continuous chip; $\boldsymbol{O}$: workpiece

   D. $\boldsymbol{M}$: continuous chip; $\boldsymbol{N}$: BUE; $\boldsymbol{O}$: workpiece

   E. $\boldsymbol{M}$: serrated chip; $\boldsymbol{N}$: continuous chip; $\boldsymbol{O}$: workpiece

9. **Discontinuous chips form under ALL of the following conditions,** ☐

   A. high α, large t_0, very high V, high machine tool stiffness

   B. low α, small t_0, normal V, low machine tool stiffness

   C. high α, large t_0, normal V, low machine tool stiffness

   D. low α, small t_0, very high V, high machine tool stiffness

   E. low α, large t_0, very high V, low machine tool stiffness

10. **Respectively, the following can be used to measure cutting forces, temperature,** ☐

    A. acoustic emission transducer, dynamometer

    B. dynamometer, acoustic emission transducer

    C. radiation pyrometer, dynamometer

    D. dynamometer, radiation pyrometer

    E. radiation pyrometer, acoustic emission transducer

☐

11. **Arrange the following parameters in *increasing* order of effect on tool life,**

   A. f, t_0, V

   B. t_0, f, V

   C. V, t_0, f

   D. t_0, V, f

   E. V, f, t_0

☐

12. **Label the high-speed steel cutting tool diagram shown below.**

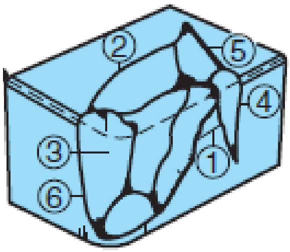
   A. ①: crater wear; ②: flank wear; ③: DOC line; ④: failure face

   B. ①: failure face; ②: DOC line; ③: flank wear; ④: crater wear

   C. ①: flank wear; ②: failure face; ③: DOC line; ④: crater wear

   D. ①: flank wear; ②: crater wear; ③: failure face; ④: DOC line

   E. ①: DOC line; ②: crater wear; ③: failure face; ④: flank wear



Questions 13-20. In an orthogonal cutting operation using a ceramic tool ($n = 0.7$), $t_o = 0.25\ mm$, $V = 400\ m/min$, $\alpha = 15°$, and $w = 8\ mm$. It is observed that $t_c = 0.45\ mm$, $F_c = 600\ N$, and the mean coefficient of friction in the cutting zone is 0.83.

☐

13. **What is the value of the *chip-compression factor*?**

   A. 0.56

   B. 0.25

   C. 0.45

   D. 0.11

   E. 1.8

☐

14. **What is the value of the *shear angle*?**

   A. 32.1°

   B. 57.9°

   C. 72.8°

   D. 49.3°

   E. 17.2°

15. **What is the value of the *shear strain*?** ☐

A. 3.27

B. 1.72

C. 1.90

D. 3.54

E. 2.22

16. **What is the value of the *shear velocity*?** ☐

A. 222 m/min

B. 404 m/min

C. 108 m/min

D. 1314 m/min

E. 723 m/min

17. **What is the magnitude of the *thrust force*?** ☐

A. 1305 N

B. 80.2 N

C. 4488 N

D. 276 N

E. 545 N

18. **Find the required *source power* given a mechanical efficiency of 65%.** ☐

A. 369 kW

B. 4.0 kW

C. 240 kW

D. 2.6 kW

E. 6.15 kW

19. **What is the effect on *increase in mean temperature* of doubling the cutting speed?** ☐

A. increase in T by 74%

B. decrease in T by 74%

C. increase in T by 26%.

D. decrease in T by 26%

E. increase in T by 41%

20. **What is the effect on *tool life* of doubling the cutting speed?** ☐

A. reduction in tool life by 37.1%

B. reduction in tool life by 62.9%

C. reduction in tool life by 61.6%

D. reduction in tool life by 38.4%

E. reduction in tool life by 50.0%

Equations, Data, Diagrams You May Find Useful

$$\log x^{p} = p\log x, \quad \log xy = \log x + \log y, \quad \log\frac{x}{y} = \log x - \log y$$

$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha} \Rightarrow r = \frac{t_0}{t_c} = \frac{\sin\phi}{\cos(\phi - \alpha)} \qquad \alpha_e = \sin^{-1}\left(\sin^2 i + \cos^2 i \sin\alpha_n\right)$$

$$r = \frac{t_0}{t_c} = \frac{V_c}{V}$$

$$Shear\ Stress = \frac{F_s}{Area\ of\ the\ shear\ plane}$$

$$\gamma = \frac{AB}{OC} = \frac{AO}{OC} + \frac{OB}{OC} \Rightarrow \gamma = \cot\phi + \tan(\phi - \alpha)$$

$$\frac{V}{\cos(\phi - \alpha)} = \frac{V_s}{\cos\alpha} = \frac{V_c}{\sin\phi}$$

$$\phi = 45^\circ + \frac{\alpha}{2} - \frac{\beta}{2} (\text{when } \mu = 0.5 \sim 2)$$

$$\Rightarrow \phi = 45^\circ + \alpha - \beta$$

$$VT^{n}d^{x}f^{y} = C$$

$$T = C^{1/n}V^{-1/n}d^{-x/n}f^{-y/n}$$

$$T \approx C^{7}V^{-7}d^{-1}f^{-4}$$

$$T = \frac{0.000665Y_f}{\rho c}\sqrt[3]{\frac{Vt_0}{K}}$$

$$Power = F_cV$$

$$\text{Power for friction} = FV_c$$

$$\text{Power for shearing} = F_sV_s$$

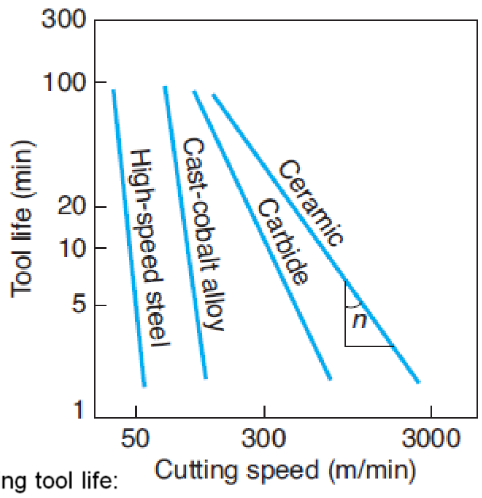
$$R_t = \frac{f^2}{8R}$$

$$T_{mean} \propto V^{a}f^{b}$$

- *Carbide tools*: *a* = 0.2, *b* = 0.125
- *High-speed steel tools*: *a* = 0.5, *b* = 0.375

$$u_t = u_s + u_f \qquad u_s = \frac{F_sV_s}{wt_0V}$$

$$u_f = \frac{FV_c}{wt_0V} = \frac{Fr}{wt_0}$$



$$\eta_{mech} = \frac{Power_c}{Power_{source}}$$

Ranges of *n* Values for the Taylor Equation (21.20a) for Various Tool Materials

High-speed steels	0.08–0.2
Cast alloys	0.1–0.15
Carbides	0.2–0.5
Coated carbides	0.4–0.6
Ceramics	0.5–0.7

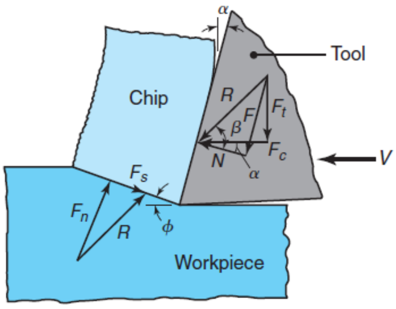
$$\mu = \tan\beta = \frac{F}{N} = \frac{F_t + F_c\tan\alpha}{F_c - F_t\tan\alpha}$$

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

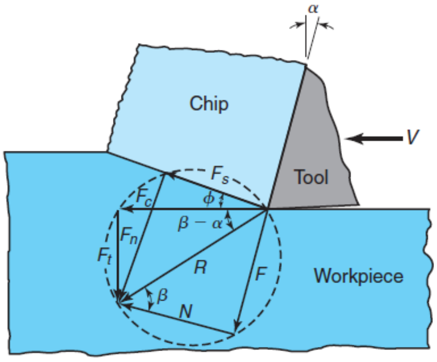
$$F_n = F_c\sin\phi + F_t\cos\phi$$

- Recommended cutting speed is one producing tool life:
  - 60-120 min: high-speed steel tools
  - 30-60 min: carbide tools

$$F_t = R\sin(\beta - \alpha) \text{ or } F_t = F_c\tan(\beta - \alpha)$$



(a)



(b)

Approximate Range of Energy Requirements in Cutting Operations at the Drive Motor of the Machine Tool (for Dull Tools, Multiply by 1.25)

Material	Specific energy W · s/mm³
Aluminum alloys	0.4–1
Cast irons	1.1–5.4
Copper alloys	1.4–3.2
High-temperature alloys	3.2–8
Magnesium alloys	0.3–0.6
Nickel alloys	4.8–6.7
Refractory alloys	3–9
Stainless steels	2–5
Steels	2–9
Titanium alloys	2–5