CLASS TEST

SL. : 01 PT_ME_ABC_050822

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Material Science+Metal Cutting

MECHANICAL ENGINEERING

Date of Test : 06/08/2022

ANSWER KEY

1.	(c)	7.	(d)	13.	(a)	19.	(b)	25.	(c)
2.	(c)	8.	(b)	14.	(b)	20.	(c)	26.	(d)
3.	(c)	9.	(c)	15.	(c)	21.	(b)	27.	(d)
4.	(a)	10.	(d)	16.	(b)	22.	(b)	28.	(d)
5.	(b)	11.	(d)	17.	(a)	23.	(b)	29.	(b)
6.	(c)	12.	( )	18.	(b)	24.	(b)	30.	(a)

DETAILED EXPLANATIONS

1. (c)

If 'a' is the lattice parameter then

Atomic radius of BCC crystal, 'r' = $\frac{a\sqrt{3}}{4}$

$$\text{atomic diameter} = 2r = \frac{a\sqrt{3}}{2} \text{ or } \frac{a}{2/\sqrt{3}}$$

2. (c)

Length of the edge of unit cell = l = 654 pm = 6.54×10^{-8} cm

Volume = $V = l^3 = (6.54 \times 10^{-8})^3$ cm^3

Molecular mass of kBr = 119 g/mol

Density = $\rho = 2.75$ g/cm^3

$$\rho = \frac{n \times M}{V \times N_o}$$

$$\Rightarrow \quad n = \frac{\rho \times v \times N_o}{M}$$

$$\Rightarrow \quad n = \frac{2.75 \times (6.54)^3 \times (6.023) \times 10^{-1}}{119}$$

$$\Rightarrow \quad n = 3.89 \simeq 4$$ (Since number of atoms will be whole number)

3. (c)

There is a invariant reaction, which does not appear on Fe-C diagram is called peritectoid reaction. When two solid phases combine together produces third solid phase upon cooling.

$$S_1 + S_2 \underset{\text{Heating}}{\overset{\text{Cooling}}{\rightleftarrows}} S_3$$

4. (a)

For discontinuous chips, rake angle should be small.

5. (b)

Cooling curve of a binary alloy may look exactly similar to that of a pure metal if it is an eutectic alloy.

6. (c)

According to Hume-Rothery rules, it is not necessary condition that elements of the system should form compounds with each other.

7. (d)

We know for the minimum power consumption,

$$2\phi + \beta - \alpha = \frac{\pi}{2}$$

$$\therefore \quad 2\phi + \beta - \alpha = 90°$$

$$2(25) + \beta - 20° = 90°$$

$$\beta = 60°$$

9. (c)

$$\tan i = -\tan\alpha_s \cos\lambda + \tan\alpha_b \sin\lambda$$

Since $i = 0$

$\therefore$ $\tan\alpha_s \cos\lambda = \tan\alpha_b \sin\lambda$

$$\tan 10 \cos\lambda = \tan 6 \sin\lambda$$

or $\tan\lambda = \dfrac{\tan 10}{\tan 6} = 1.6776$

$$\lambda = 59.2°$$

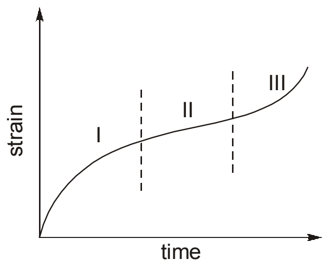
$$90 - c_s = 59.2°$$

$$c_s = 30.8°$$

10. (d)

11. (d)

Creep curve shows the increase in plastic strain as a function of time.



It consists of 3 stages:

- In stage I, creep rate decreases with time.
- In stage II, creep rate is minimum and constant with time.
- In stage III, creep rate increases with time until fracture occurs.

12. (10.186)(10.1 to 10.3)

Approach angle, $\lambda = 75°$

Side cutting edge angle, $C_s = 90° - \lambda$

$$= 90° - 75° = 15°$$

Mean surface roughness, $R_a = 3\ \mu m$

$$= 3 \times 10^{-3}\ \text{mm}$$

Maximum height of roughness, $H_{max} = 4 R_a$

$$= 4 \times 3 \times 10^{-3} = 12 \times 10^{-3}\ \text{mm}$$

As we know,

$$H_{max} = \frac{f}{\tan C_s + \cot C_e}$$

$$12 \times 10^{-3} = \frac{0.07}{\tan 15 + \cot C_e}$$

$$\tan 15 + \cot C_e = 5.8333$$

$$\cot C_e = 5.5654$$

$\Rightarrow$ $C_e = 10.186°$

So, end cutting edge angle, $C_e = 10.186°$

13. (a)

Friction angle for dry cutting,

$$\tan\beta_{dry} = \frac{F_t + F_C \tan\alpha}{F_C - F_t \tan\alpha} = \frac{740 + (1330)\tan(-5°)}{1330 - 740\tan(-5°)}$$

$$\beta = 24.09°$$

for when coolant is used,

$$\tan\beta_{coolant} = \frac{710 + 1200\tan(-5°)}{1200 - 710\tan(-5°)}$$

$$\beta = 25.61°$$

$$\text{Change in friction angle} = 25.61° - 24.09° = 1.52°$$

14. (b)

Jominy end-quench test is carried out to determine hardenability of steel and not hardness.

15. (c)

$$t = f\sin\lambda = 0.4 \sin 60° = 0.346 \text{ mm}$$

$$r = \frac{t}{t_c} = \frac{0.346}{0.8} = 0.43$$

$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha} = \frac{0.43\cos 15°}{1 - 0.43\sin 15°} = 0.467$$

$$\phi = \tan^{-1}(0.467) = 25°$$

$$\text{Shear strain, } \gamma = \tan(\phi - \alpha) + \cot\phi$$

$$= \tan(10°) + \cot 25°$$

$$= 2.321$$

$$\text{Shear strain rate, } \dot{\gamma} = \frac{\cos\alpha}{\cos(\phi - \alpha)} \times \frac{V}{\Delta y} = \frac{\cos 15°}{\cos 10°} \times \frac{150/60}{9 \times 10^{-6}}$$

$$= 2.7 \times 10^5 \text{ s}^{-1}$$

16. (b)

0° - 10° - 6° - 6° - 8° - 75° – 1 (mm) ORS

$i = 0$, $\alpha = 10°$, $\lambda = 75°$

$$\tan\alpha_s = \sin\lambda \tan\alpha - \cos\lambda \tan i$$

$$\tan\alpha_s = \sin 75 \tan 10 - \cos 75 \tan 0$$

$$\tan\alpha_s = 0.170318$$

$$\alpha_s = 9.66°$$

17. (a)

Mechanically, gray cast iron is comparitively weak and brittle in tension whereas their strength and ductility is much higher under compressive loads.

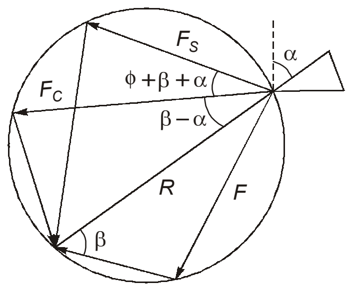
18. (b)

19. (b)

- The iron-carbon diagram is plotted under equilibrium conditions and TTT curve is plotted under non-equilibrium conditions.
- The main purpose of spheroidising treatment is to improve machinability of high carbon steel.
- The martensitic transformation is a process of shear, that occurs without any need for diffusion so there will be no change in composition in this process.

20. (c)

By Merchant's theory



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

$$\alpha = 7°$$
$$\beta = ?$$
$$\phi = ?$$

$$\tan\phi = \frac{r\cos\alpha}{1-r\sin\alpha} = \frac{0.5\cos7°}{1-0.5\sin7°}$$

$$\phi = 27.8553°$$
$$2\phi = 90 + \alpha - \beta$$
$$2 \times 27.8553 = 90 + 7 - \beta$$
$$\beta = 41.2892°$$

$$F_s = \frac{\tau_s bt}{\sin\phi} = \frac{250\times3\times0.2}{\sin27.8553°} = 321.0340 \text{ N}$$

$$F_c = 321.0340\times\frac{\cos(41.2892-7)}{\cos(41.2892+27.8553-7)}$$

$$F_c = 567.66 \text{ N}$$

21. (b)

For minimum power,

$$2\phi + \beta - \alpha = 90°$$

$$\Rightarrow \quad \beta - \alpha = 20° \qquad [\because \phi = 35°]$$

$$\tan(\beta-\alpha) = \frac{F_T}{F_C} = \tan20°,$$

$$\therefore \quad \frac{F_C}{F_T} = 2.747$$

22. (b)

23. (b)

The cutting edge, in orthogonal cutting, is always normal to the cutting velocity.

25. (c)

As Taylor's equation, $VT^n = C$

or $V_1T_1^n = V_2T_2^n$

$\Rightarrow$ $V_1 = V$

and $V_2 = \frac{1}{2}V$ and $n = 0.2$

$\Rightarrow$ $V(T_1)^{0.2} = \frac{V}{2}(T_2)^{0.2}$

or $T_2 = 2^{1/0.2} \times T_1 = 32T_1$

$\Rightarrow$ $T_2 = 32\,T_1$

28. (d)

According to lever rule, the fraction of solid phase is

$$x_s = \frac{C_L - C_0}{C_L - C_S} = \frac{72-48}{72-26} = 52\%$$

29. (b)

$$F_s = F_c \cos\phi - F_t \sin\phi = 750\cos 25° - 550\sin 25° = 447.29 \text{ N}$$

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