CLASS TEST

S.No. : 01SP_ME_A+C_150223

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CASTING + WELDING & FORMING

MECHANICAL ENGINEERING

Date of Test : 15/02/2023

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (a)

Gating ratio is defined as the ratio of cross-section area of spure, runner and ingate.

3. (c)

$$V = \sqrt{2gh}$$

$$= \sqrt{2 \times 981 \times 20} = 198.09 \text{ cm/sec}$$

$$t = \frac{\text{Volume of mold}}{\text{Ingate area} \times \text{Velocity}}$$

$$= \frac{\pi/4 \times (40)^2 \times 15}{\pi/4 \times 2^2 \times 198.09} \simeq 30 \text{ seconds}$$

4. (b)

$$\text{diameter, } d = 1000 \text{ mm}$$

$$\text{thickness, } h = 30 \text{ mm}$$

$$K = 2.1 \text{ sec/mm}^2$$

$$\text{Solidification time } (T) = K\left(\frac{V}{S}\right)^2$$

$$\text{Volume} = \frac{\pi}{4} \times (1000)^2 \times 30$$

$$= 23561944.9 \text{ mm}^3$$

$$\text{Surface area} = \left(2 \times \frac{\pi}{4} d^2 + \pi dh\right) = \frac{\pi}{2} \times 1000^2 + \pi \times 1000 \times 30$$

$$= 1665044.106 \text{ mm}^2$$

$$T = 2.1 \times \left(\frac{23561944.9}{1665044.106}\right)^2$$

$$= 420.5 \text{ sec}$$

5. (a)

$$\text{Diameter} = 400 \text{ mm}$$

$$\Delta h = 2R(1 - \cos\alpha)$$

$$1.25 = 2 \times 200(1 - \cos\alpha)$$

$$\left(\frac{1.25}{2 \times 200}\right) = (1 - \cos\alpha)$$

$$\alpha = 4.53°$$

6. (a)

$$\eta_{melting} = \frac{\text{Net heat required to melt the joint}}{\text{Net heat supply}}$$

$$I = \frac{10 \times 5 \times 5 \times 10}{0.85 \times 0.60 \times 25} = 196.07 \text{ A}$$

7. (a)

Since there is no change in metal volume at a given point per unit time throughout the process, therefore

$$b_i h_i v_i = b_f h_f v_f$$

$$\frac{h_f}{h_i} = \frac{1}{3}$$

$$\frac{b_f}{b_i} = 1.03$$

$$v_f = \frac{b_i}{b_f}\frac{h_i}{h_f}v_i = \frac{1}{1.03}\times 3\times 12 = 34.9514 \text{ m/min}$$

8. (b)

In straight polarity, electrode is negative and workpiece is positive, hence more heat is generated at workpiece resulting in greater penetration but due to lower heat generation at electrode end, melting rate of electrode reduces causing low deposition rate.

9. (a)

$$h_1 = 25 \text{ mm}$$

$$h_2 = (1-0.2)\times 25$$

$$h_2 = 20 \text{ mm}$$

Roll strip contact length, $L = \sqrt{R\Delta H}$

$$L = \sqrt{250\times(25-20)}$$

$$L = \sqrt{250\times 5} = 35.355 \text{ mm}$$

11. (c)

$$V = OCV - \left(\frac{OCV}{SSC}\right)I$$

OCV $\rightarrow$ Open Circuit Voltage

SSC – Short Circuit Current

$$V = 120 - \left(\frac{120}{360}\right)I$$

$$P = VI = \left[120I - \left(\frac{120}{360}\right)I\right]I$$

$$P = 120I - \left(\frac{120}{360}\right)I^2$$

For maximum power

$$\frac{dP}{dI} = 0$$

$$120 - 2\left(\frac{120}{360}\right)I = 0$$

$$120 - \frac{2}{3}I = 0$$

$$\frac{2}{3}I = 120$$

$$I = \frac{120\times 3}{2} = 180 \text{ amp.}$$

12. (c)

$$F = \frac{F_{max}\, pt}{pt + S}$$

$$\Rightarrow \quad F = \frac{F_{max}\, 0.2 \times 5}{0.2 \times 5 + 1.5} = \frac{2F_{max}}{5}$$

$$\%\text{ reduction} = \frac{F_{max} - F}{F_{max}} \times 100\% = \left(1 - \frac{2}{5}\right) \times 100\% = 60\%$$

13. (b)

Shrinkage volume of casting = $0.026 \times 100 \times 100 \times 50$

= 13000 mm^3

Volume of riser = $4 \times 13000 = 52000 \text{ mm}^3$

$$d^2 = \frac{52000 \times 4}{\pi \times 80}$$

$$d = 28.7681 \text{ mm}$$

15. (b)

$$h_1 = 30 \text{ mm}$$
$$h_2 = 10 \text{ mm}$$
$$D = 600 \text{ mm}$$
$$(\Delta h)_{max} = n\mu^2 R$$
$$n = \frac{20}{0.1^2 \times 300} = 6.66 \simeq 7$$

16. (a)

The correct sequence of these operation is : Flattening $\rightarrow$ Upsetting $\rightarrow$ Swagging $\rightarrow$ Cambering.

17. (b)

Energy utilized as heat = $0.8 \times VI$

= $0.8 \times 20 \times 200$

= 3200 W

$\therefore$ Heat required = $V \times 10$; $V \rightarrow$ Volume of nugget

$\therefore$ Net heat available = Heat required

$3200 \times .625 = V \times 10$

$3200 \times 0.625 = v \times 8 \times 5 \times 10$ (v : welding speed)

$\Rightarrow$ $v = 5$ mm/s

18 (b)

Let r be the radius of the blank required then,

$$\pi r^2 = 2\pi\, (10)^2$$

$$r = 10\sqrt{2}$$

19. (b)

$$V_g = \sqrt{2 \times 10 \times 1000 \times 50} = 1000 \text{ mm/s}$$

For top gate, $$t_f = \frac{\text{Volume of mould}}{(\text{Area of gate})\ (V_g)}$$

$$= \frac{150 \times 100 \times 50}{150 \times 1000} = 5 \text{ seconds}$$

For bottom gate, $$t_{f_1} = 2\ t_f = 10 \text{ seconds} \qquad (\because h_m = h_s)$$

20. (b)

Drawing force, $$F = \sigma_d \times A_f = 357 \times \frac{\pi}{4} \times (0.8 \times 10)^2$$

$$= 17944.777 \text{ N}$$

$$\text{Power} (P) = F \times V = 17944.777 \times 0.5$$

$$= 8972.38 \text{ W} = 8.97 \text{ kW}$$

21. (b)

$$F = A_i K \ln\left(\frac{A_i}{A_f}\right)$$

$$P = \frac{F}{A_i} = K \ln\left(\frac{A_i}{A_f}\right)$$

$$= 250 \times \ln 4 = 346.57 \text{ MPa}$$

22. (a)

$$\text{Heat generated} = (I^2 R\, t)$$

$$= (12000)^2 \times 200 \times 10^{-6} \times \frac{5}{50}$$

$$= 2880 \text{ J}$$

23. (b)

$$V = \sqrt{2gh'}$$

$$h' = 50 - 0.22 \times 50$$

$$h' = 0.39 \text{ m}$$

$$V = \sqrt{2 \times 9.81 \times 0.39} = 2.766 \text{ m/s} = 276.6 \text{ cm/s}$$

24. (a)

$\because$ The volume remains constant,

$$\frac{\pi}{4}D_1^2 L_1 = \frac{\pi}{4}D_2^2 L_2$$

$$\therefore \quad D_1^2 L_1 = D_2^2 L_2$$

$$400^2 \times 100 = 800^2 \times L_2$$

$$L_2 = 25 \text{ mm}$$

$$\varepsilon = \frac{L_2 - L_1}{L_1}$$

$$\varepsilon = \frac{25-100}{100} = -0.75$$

$$\text{True strain} = \ln(1 + (-0.75) = \ln(0.25) = -1.386$$

26. (c)

$$t = K\left(\frac{V}{SA}\right)^2$$

For cube $\quad \dfrac{V}{SA} = \left(\dfrac{a^3}{6a}\right)^2 \quad$ [a is the side of cube]

$$\frac{t_1}{t_2} = \frac{a_1^2}{a_2^2}$$

$$\Rightarrow \quad t_2 = 5\left(\frac{a_2}{a_1}\right)^2$$

$V_2 = \dfrac{V_1}{8} \quad$ [as density is constant]

$$\Rightarrow \quad a_2 = \frac{a_1}{2}$$

$$t_2 = \frac{5}{4}$$

$$t_2 = 1.25 \text{ minutes}$$

27. (d)

$$L(t) = L_0(1 + 2t^3)$$

So, $\quad dL = L_0(6t^2)\,\text{dt}$

True strain (ε_T) at any instant of time,

$$\varepsilon_T = \int_0^t \frac{dL}{L} = \int_0^t \frac{L_0\left(6t^2\right)dt}{L_0(1+2t^3)}$$

$$\Rightarrow \quad \varepsilon_T = \ln(1 + 2t^3)$$

and true strain rate at the end of 1 minute,

$$\left.\frac{d\varepsilon_T}{dt}\right|_{t=1} = \frac{d\left(\ln\left(1+2t^3\right)\right)}{dt} = \left.\left(\frac{1}{1+2t^3}\right)\left(6t^2\right)\right|_{t=1}$$

$$\dot{\varepsilon}_T = \left\{\frac{1}{1+2(1)^3}\right\}\left(6(1)^2\right) = 2.0 \text{ per min}$$

28. (b)

Drawing stress, $$\sigma_d = \sigma_o\left(\frac{1+B}{B}\right)\left[1-\left(\frac{r_f}{r_o}\right)^{2B}\right]$$

For maximum reduction,

$$\sigma_d = \sigma_o$$

$$\Rightarrow \quad 1 = \left(\frac{1+B}{B}\right)\left(1-\left(\frac{r_f}{r_o}\right)^{2B}\right)$$

$$B = \mu\cot\alpha = 0.15\cot\left(\frac{20}{2}\right) = 0.85$$

So, $$1 = \left(\frac{1+0.85}{0.85}\right)\left(1-\left(\frac{r_f}{r_o}\right)^{1.70}\right)$$

$$\Rightarrow \quad \frac{r_f}{r_o} = 0.6963$$

Now, maximum possible reduction in area,

$$\frac{A_o - A_f}{A_o} = \frac{1-(0.6963)^2}{1} = 51.50\%$$

29. (c)

For slush casting,

$$t = C_1\sqrt{t_s} + C_2$$

$$t \propto \sqrt{t_s}$$

$$\Rightarrow \quad \frac{t_1}{t_2} = \left(\frac{t_{s1}}{t_{s2}}\right)^{1/2}$$

$$\Rightarrow \quad \frac{8}{2} = \left(\frac{25}{t_{s2}}\right)^{1/2}$$

$$\Rightarrow \quad t_{s2} = 1.5625 \text{ min}$$

$$t_{s2} = 93.75 \text{ seconds} \simeq 94 \text{ seconds}$$

30. (b)

Given: h_i = 20 mm, h_f = 18 mm, $\Delta h = h_i - h_f$ = 2 mm

Maximum draft possible $(\Delta h)_{max} = \mu^2 R$

$$= (0.15)^2 (200) = 4.5 \text{ mm}$$

Roll strip length, $$l_p = \sqrt{R(\Delta h)} = \sqrt{(200)(2)} = 20 \text{ mm}$$

Rolling force, $$F = l_p \times w \times \bar{\sigma}_f$$

$$F = 20 \times 250 \times 165.8 = 829 \text{ kN}$$

Now, Torque required to drive each roll,

$$T = a \times F = 0.5 l_p \times F$$

$$= 0.5 \times 20 \times 829 = 8290 \text{ kN-mm}$$

$$T = 8290 \text{ Nm}$$

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