



UPPSC AE 2020 PAPER-1

Mechanical Engineering

Mini Mock Challenge

(November 5 - November 6 2020)

Questions & Solutions



- सही म्हावरे को मिलायें। 1.
 - A) अपना उल्लू सीधा करना 1. कंगाल होना
 - B) उन्नीस बीस का अंतर होना 2. जबरदस्त बदला लेना
 - C) ईंट का जबाब पत्थर से देना -
- 3. बह्त कम अंतर होना
- D) फूटी कौड़ी न होना
- 4. मतलब निकालना
- A. A-1 B-2 C-3 D-4

B. A-4 B-1 C-3 D-2

C. A-4 B-3 C-2 D-1

D. A-2 B-4 C-3 D-1

Ans. C

Sol. मुहावरों का अर्थ - मुहावरे का शाब्दिक अर्थ होता है - अभ्यास। विशेष अर्थ को प्रकट करने वाले वाक्यांश को म्हावरा कहते हैं।

अपना उल्लू सीधा करना - मतलब निकालना

उन्नीस बीस का अंतर होना - बह्त कम अंतर होना

ईंट का जबाब पत्थर से देना - जबरदस्त बदला लेना

फूटी कौड़ी न होना - कंगाल होना

- 2. निम्नलिखित में से कौन-सा शब्द बह्वचन है?
 - A. पुस्तक

B. लड़का

C. पौधा

D. प्राण

Ans. D

Sol. वचन - शब्द के जिस रूप से उसके एक अथवा अनेक होने का बोध हो उसे वचन कहते हैं।

बह्वचन - शब्द के जिस रूप से अनेकता का बोध हो उसे बह्वचन कहते हैं। जैसे- रोटियाँ, बेटे आदि।

प्राण, दर्शन और हस्ताक्षर हिंदी में वे गिने-चुने शब्द हैं जो हमेशा बह्वचन रूप में उपयोग किए जाते हैं। उदाहरण: प्राण

सभी को प्यारे होते हैं।

लड़का - लड़के

पौधा - पौधे

प्स्तक - प्स्तके

- "परिश्रम के बाद विश्राम आवश्यक है" वाक्य के लिए उपयुक्त लोकोक्ति है। 3.
 - A. दाँतो तले ऊँगली दबाना

B. थका ऊँट सराय ताकता है

C. आज काज महाकाज

D. बाँह गहे की लाज

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Ans. B

Sol. लोकोक्ति - किसी विशेष स्थान पर प्रसिद्ध हो जाने वाले कथन को 'लोकोक्ति' कहते हैं।

"थका ऊँट सराय ताकता है" - परिश्रम के बाद विश्राम आवश्यक है

अन्य लोकोक्तियाँ -

दाँतो तले ऊँगली दबाना - आश्चर्यचिकत रह जाना

आज काज महाकाज - स्वंय करने पर ही कार्य ठीक होता है

बाँह गहे की लाज - शरणागत की रक्षा करना

4. 'मुझसे उठा नहीं गया' वाक्य में वाच्य है।

A. कृत्रवाच्य

B. कर्मवाच्य

C. भाववाच्य

D. उपर्य्क्त में से कोई नहीं

Ans. C

Sol. **भाववाच्य -** क्रिया के उस रूपान्तर को भाववाच्य कहते हैं, जिससे वाक्य में क्रिया अथवा भाव की प्रधानता का बोध हो । क्रिया के लिंग वचन कर्म के लिंग एवं वचन के अनुसार होते है।

जैसे- मोहन से टहला भी नहीं जाता।

वाच्य का अर्थ: क्रिया के उस परिवर्तन को वाच्य कहते हैं, जिसके द्वारा इस बात का बोध होता है कि वाक्य के अन्तर्गत कर्ता, कर्म या भाव में से किसकी प्रधानता है।

5. '**हतभागी**' का स्त्रीलिंग शब्द है।

A. हतभागनी

B. हतभाग्यवती

C. हतभाग्या

D. हतभाग्

Ans. C

Sol. लिंग -"संज्ञा के जिस रूप से व्यक्ति या वस्तु की नर या मादा जाति का बोध हो, उसे व्याकरण में 'लिंग' कहते है।
स्त्रीलिंग - जिस संज्ञा शब्द से स्त्री जाति का बोध होता है, उसे स्त्रीलिंग कहते है।
हतभागी शब्द पुल्लिंग है जिसका स्त्रीलिंग शब्द हतभाग्या होता है।
हतभागी शब्द का अर्थ - अभागा, बदिकस्मत, भाग्यहीन

6. इस वाक्य में किस प्रकार के चिन्हों का प्रयोग ह्आ है?

"आह! बहुत दर्द हो रहा है।"

A. कोष्ठक चिन्ह+विराम

B. विराम चिन्ह+अर्द्ध विराम

C. अर्दध विराम+प्रश्नवाचक

D. विस्मयादिबोधक+पूर्ण विराम

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Ans. D

- Sol. दिए गए वाक्य में सबसे पहले आह के बाद विस्मयादि बोधक चिन्ह का प्रयोग हुआ है। इस चिन्ह का प्रयोग विस्मय, शोक, घृणा, प्रेम आदि की स्थिति में किया जाता है जबकि वाक्य के अंत में पूर्ण विराम के चिन्ह का उपयोग हुआ है।
- 7. निम्नलिखित में से कौन-सा 'ओष्ठ्य' वर्ण नहीं है?
 - A. ट्

В. प

C. फ

D. भ्

Ans. A

Sol. वर्णमाला : हिंदी भाषा की सबसे छोटी इकाई ध्विन होती है। इसी ध्विन को ही वर्ण कहा जाता है। वर्णों को व्यवस्थित करने के समूह को वर्णमाला कहते हैं।

उच्चारण स्थान - मुख के जिस स्थान से जो वर्ण या ध्विन निकलती है , वह भाग उसका उच्चारण स्थान है। ओष्ठ्य उच्चारण स्थल से उच्चारित वर्ण – प् फ् ब् भ् म्

अन्य वर्ण -

- 1. कण्ठ्य कवर्ग- क् ख् ग् घ् ङ्
- 2. तालव्य चवर्ग- च् छ् ज् झ् ञ्
- 3. मूर्द्धन्य टवर्ग- ट् ठ् ड् ढ् ण् (ड् ढ्)
- 4. दन्त्य तवर्ग- त् थ् द् ध् न्
- 8. निम्न में से ग्ण संधि है -
 - A. प्राणायाम

B. हितैषी

C. वीरोचित

D. अत्यधिक

Ans. C

Sol. प्राणायाम = प्राण + आयाम

हितैषी = हित + ऐषी

वीरोचित = वीर+3चित

अत्यधिक = अति + अधिक

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9. जोड़कर लिखिए । (समानार्थक शब्द)

| 'अ' | 'b' |
|------------|----------|
| A. धरा | 1) इच्छा |
| B. अभिलाषा | 2) काला |
| c. कृष्ण | 3) धरती |
| D. गगन | 4) नभ |

A. a-3 b-1 c-2 d-4

B. a-1 b-3 c-2 d-4

C. a-3 b-2 c-1 d-4

D. a-2 b-1 c-3 d-4

Ans. A

Sol. शब्दों के अर्थ -

धरा- धरती, पृथ्वी, संसार अथवा जमीन को कहते हैं।

अभिलाषा-मन की चाह, कामना अथवा इच्छा को कहते हैं।

कृष्ण-इसका अर्थ काला अथवा श्याम होता है।

गगन- गगन का अर्थ आकाश, नभ अथवा आसमान होता है।

10. निम्नलिखित में से श्द्ध वाक्य है -

A. कोहिन्र एक अमूल्य हीरा है।

B. परीक्षा की प्रणाली बदलनी चाहिए।

C. विख्यात आतंकवादी मारा गया।

D. राम ने रावण की हत्या की।

Ans. B

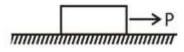
Sol. परीक्षा की प्रणाली बदलनी चाहिए" वाक्य शुद्ध है अन्य विकल्पों में व्याकरण सम्बन्धी अशुद्धि हैं -

राम ने रावण की हत्या की। - राम ने रावण का वध किया।

विख्यात आतंकवादी नारा गया। - क्ख्यात आतंकवादी मारा गया।

कोहिन्र एक अम्लय हीरा है। - कोहिन्र एक बह्म्लय हीरा है।

11. What will be the magnitude of the force P needed to just impend the motion of the block? (If the weight of the block is 80N and coefficient of friction is 0.4)



A. 80N

B. 0N

C. 32N

D. 112N

Ans. C

Sol. The magnitude of the force P needed to just impend the motion of the block will be equal to the limiting friction or maximum static friction –

 $P = f_r = \mu N$

 $P = 0.4 \times 80 \rightarrow 32 \text{ N} \text{ (} N=Mg = 80 \text{ N)}$

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- 12. The speed of an engine varies from 210 rad/s to 190 rad/s. during cycle the change in kinetic energy is found 400 Nm and coefficient of fluctuation of speed is 0.1 the inertia of the flywheel (in kgm²) is ?
 - A. 0.1

B. 0.2

C. 0.3

D. 0.4

Ans. A

Sol. given,

$$\Delta E = 400Nm$$

$$c_s = 0.1$$

$$\omega_{min} = 190 rad/s$$

$$\omega_{max} = 210 rad/s$$

$$\omega_{mean} = \frac{\omega_{min} + \omega_{max}}{2} = \frac{190 + 210}{2}$$

$$\omega_{mean} = 200 rad/s$$

$$\Delta E = I\omega^2 c_s$$

$$400 = I \times 200^2 \times 0.1$$

$$I = 0.1 \text{ kg-m}^2$$

- 13. A 5 station assembly line has allotted times 7,9,8,6 and 5 minutes respectively. What is the balance delay?
 - A. 20.03%

B. 22.22%

C. 25.30%

D. 28.32%

Ans. B

Sol. Balance delay is given by:

$$BD = \left(1 - \frac{T_{wc}}{nT_c}\right) \times 100\%$$

Where:

 T_c = Cycle time (largest of all station times)

 T_{wc} = total work content

n = number of stations

$$BD = \left(1 - \frac{(7+9+8+6+5)}{5 \times 9}\right) \times 100 = 22.22\%$$

- 14. Principal strains at a point are $+100\times10^{-6}$ and -200×10^{-6} . What is the maximum shear strain at the point?
 - A. 300×10^{-6}

B. 200×10^{-6}

C. 150×10⁻⁶

D. 100×10⁻⁶

Ans. A

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Sol. Maximum shear strain

Principal strains at a point are $+100\times10^{-6}$ and -200×10^{-6}

$$\varepsilon_1 = 100 \times 10^{-6}$$

$$\varepsilon_2 = -200 \times 10^{-6}$$

$$\frac{\gamma}{2} \!=\! \frac{\varepsilon_1 \!-\! \varepsilon_2}{2}$$

$$\gamma = 100 \times 10^{-6} - (-200 \times 10^{-6})$$

$$\gamma = 300 \times 10^{-6}$$

15. Two alternatives can produce a product. First has a fixed cost of Rs. 2000 and a variable cost of Rs. 20 per piece. The second method has a fixed cost of Rs. 1500 and a variable cost of Rs.30. The break even quantity between the two alternatives is

B. 50

C. 75

D. 100

Ans. B

Sol.

| Machine | Fixed cost | Variable cost |
|---------|------------|---------------|
| Α | 2000 | 20 |
| В | 1500 | 30 |

break even point is the quantity at which total cost from both the machine is same.

If x is the break even quantity, then

$$2000 + 20x = 1500 + 30x$$

or,
$$x = 50$$
.

16. Match **List-I** (Type of Gear/Gear Train) with **List-II** (different Usage and drive) and select the correct answer using the code given below the lists:

List-I

- A) Epicyclic gear train
- B) Bevel Gear
- C) Worm and worm gear
- D) Herringbone Gear

List-II

- 1) Reduces end thrust
- 2) Low gear ratio
- 3) Drives non-parallel non-intersecting shafts
- 4) Drives non-parallel intersecting shafts
- 5) High gear ratio

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A. A-5; B-4; C-3; D-1

C. A-5; B-3; C-4; D-1

B. A-2; B-3; C-4; D-5 D. A-2; B-4; C-3; D-5

Ans. A

Sol. 1) Epicycle gear train \rightarrow high gear ratio

- 2) Bevel gear → Drives non-parallel intersecting shafts
- 3) Worm-worm gear → Drives non- parallel, non- intersecting shafts
- 4) Herringbone gear → Reduce end thrust.
- 17. Which of the following Sensor has applications in measuring the displacement or position or proximity?

A. Optical encoders

B. Piezometer sensor

C. Tactile sensors

D. Thermocouples

Ans. A

Sol.

- Optical encoders provide a digital output as a result of linear/angular displacement. It compresses of a disc with three concentric tracks of equally spaced holes.
- Three light sensors are employed to detect the light passing through holes. These sensors produce electric pulses which give the angular displacement of element.
- 18. Which kind of distribution is used in PERT for activity and project?

A. Normal & Beta

B. Beta & Normal

C. Normal & Normal

D. Beta & Beta

Ans. B

Sol. In PERT for Activity = Beta Distribution

In PERT for Project = Normal Distribution

19. Match **List-I** (Effect of Cooling) with **List-II** (Cooling Medium) and select the correct answer using the codes given below the lists:

List-II List-II

[A]. Martensite [1]. Water quenched

[B]. Very fine pearlite [2]. Air cooled

[C]. Fine pearlite [3]. Furnace cooled

[D]. Coarse pealite [4]. Oil quenched

A. A-1, B-4, C-2, D-3

B. A-2, B-3, C-1, D-4

C. A-2, B-3, C-4, D-1

D. A-1, B-2, C-3, D-4

Ans. A

Sol. Martensite:

The martensitic reaction begins during cooling when the austenite reaches the martensite start temperature (M_s) and the parent austenite becomes mechanically unstable. As the sample is quenched, an increasingly large percentage of the austenite transforms to martensite until the lower transformation temperature M_f is reached, at which time the transformation is completed.





Very fine pearlite:

Oil quenching leads to a formation of relatively *fine* ferrite and *pearlite* grains in comparison to normal air and forced air *cooling*. Relatively *fine* ferrite, *pearlite* increase strength but decrease ductility. The *cooling* rate has a remarkable *effect* on the microstructure and mechanical properties at room temperature.

Fine pearlite:

The eutectoid composition of austenite is approximately 0.76% carbon; steel with less carbon content (hypoeutectoid steel) will contain a corresponding proportion of relatively pure ferrite crystallites that do not participate in the eutectoid reaction and cannot transform into pearlite. Likewise steels with higher carbon content (hypereutectoid steels) will form cementite before reaching the eutectoid point.

Coarse pealite:

The formation of pearlite also indicates that the transformation occurs sooner at low temperatures, which is an indication that it is controlled by the rate of nucleation. At low temperatures, nucleation occurs fast and grain growth is reduced (since it occurs by diffusion, which is hindered at low temperatures). This reduced grain growth leads to fine-grained microstructure (fine pearlite). At higher temperatures, diffusion allows for larger grain growth, thus leading to coarse pearlite.

20. A torsion is applied on a shaft at its one end whereas the other end is fixed. then, Shear stress induced by torsion at circumference and at centre respectively will be,

A. Zero, Zero

B. Maximum, Maximum

C. Maximum, zero

D. Zero, maximum

Ans. C

Sol.

from the torsion equation,

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$$

from above equation.

 $T \propto r$

at circumference , $r = r_{max}$ thus shear stress will be maximum.

at center, r = 0, thus shear stress will be zero.

21. Atomic Packing fraction (In percentage) of face-centered cubic structure is equal to

A. 74

B. 52

C. 68

D. 66

Ans. A

Sol. Atomic Packing fraction of face-centered cubic structure is equal to 74%





- 22. Which of the following is/are the functions of microprocessor?
 - A. If performs the logical and mathematical operations using its ALU.
 - B. It controls data flow in a system and hence can transfer data from one location another.
 - C. It takes necessary decision.
 - D. All of above

Ans. D

- Sol. A microprocessor performs the following functions:
 - (i) If performs the logical and mathematical operations using its ALU.
 - (ii) It controls data flow in a system and hence can transfer data from one location another.
 - (iii) It takes necessary decision.
- 23. In a car workshop the arrival rate is 5 per hr and the service rate was found to be 8 per hr. what is the waiting time in system?

A. 10 min

B. 20 min

C. 30 min

D. 40 min

Ans. B

Sol. Given,

Arrival rate $(\lambda) = 5 \text{ Car/hr}$

Service rate $(\mu) = 8 \text{ Car/hr}$

Waiting time in System (Ws)

$$W_s = \frac{1}{(\mu - \lambda)} = \frac{1}{3} \text{ hr} = \frac{60}{3} \text{ min} = 20 \text{ min}$$

24. The demand and forecast in a Manufacturing plant for November are 17000 and 15500 orders respectively. By using simple exponential smoothing method, forecast for the month of December will be? Use smoothing coefficient= 0.26

A. 16890

B. 1589

C. 15890

D. 15690

Ans. C

Sol. Forecasting using exponential smoothing method is given by:

$$F_{Dec} = F_{Nov} + \alpha (D_{Nov} - F_{Nov})$$

$$F_{Dec} = 15500 + 0.26 \times (17000 - 15500)$$

 $F_{Dec} = 15890$

- 25. The welding process in which bare wire is used as electrode, granular flux is used and the process is characterized by its high speed welding, is known as
 - A. Shielded are welding

B. Plasma arc welding

C. Submerged arc welding

D. Gas metal arc welding

Ans. C

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Sol. Submerged arc welding process is a process in which bare electrode usually copper coated to increase the conductivity, granular flux is used.

Advantages of submerged arc welding are:

- 1. A constant arc length can be maintained which improves the bead quality.
- 2. Long weld run can be performed in one setup
- 26. For a belt drive application, the difference between tensions on the slack & tight sides is 3000N. Determine the transmitted power in kW, if the belt speed is 15 m/s:

A. 45

B. 22.5

C. 90

D. 100

Ans. A

Sol. Given, $T_1 - T_2 = 3000N$

where, T_1 , T_2 are tension on tight & slack sides respectively.

v is belt speed = 15 m/sec

 \therefore Power = $(T_1 - T_2)v$

: Power = $3000 \times 15 = 45000 \text{ watt} = 45 \text{ kW}$

27. A ball of mass 2kg is revolved in a vertical circle at a speed of 5rad/s through a rope of nylon of length 0.5m. Calculate the maximum and the minimum tension in the rope.

(Take $g = 10 \text{m/s}^2$)

A. Max = 45N Min = 20N

B. Max = 20N Min = 0N

C. Max = 5N Min = 0N

D. Max = 45N Min = 5N

Ans. D

Sol. The maximum and minimum tension will occur in the rope at the bottom-most and the topmost point of the circle. Since, it is a vertical circle problem. Therefore, effect of weight of ball will be taken into account.

Maximum tension:

$$T_{max} = mg + mr\omega^2$$

$$T_{max} = 20 + 25 = 45N$$

Minimum tension:

$$T_{min} = mr\omega^2 - mg$$

$$T_{min} = 25 - 20 = 5N$$

28. A pinned-pinned circular column whose slenderness ratio is 'S' is heated uniformly by an external source. If the modulus of elasticity of the column material is E and its coefficient of thermal expansion is a, then calculate the change in temperature required to make the column buckle.



Ans. A

Sol. Column will buckle when thermal stress = Buckling stress

Buckling stress =

$$\sigma = \frac{\pi^2 E K^2}{\int_e^2 S = \frac{I_e}{K}}$$

$$\sigma = \frac{\pi^2 E}{s^2}$$

Thermal stress = $E\alpha\Delta T$

Equating the two,

$$\frac{n^2 E}{S^2} = E a \triangle T$$

$$\Delta T = \frac{\pi^2}{\alpha S^2}$$

29. The property of bearing material which has the ability to accommodate small particles of grit, dust, etc. without much scoring and wearing of journal material is called:

A. bondability

B. conformability

C. fatigue strength

D. embeddability

Ans. D

- Sol. Embeddabilty is the vital property for a bearing material to accommodate small particles of grit, dust, etc. without much scoring and wearing of journal material.
- 30. The non-traditional machining process that essentially requires vacuum is ___

A. electron beam machining

B. electro chemical machining

C. electro chemical discharge machining D. electro discharge machining

Ans. A

Sol.

- In electron- beam machining, vacuum conditions are created/required for material removal, because electrons move efficiently in vacuum.
- What are the co-ordinates of center of Mohr's circle for an element subjected to two 31. mutually perpendicular stresses one tensile of magnitude 80MPa and other compressive of magnitude 50MPa?

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A. (65,0)

B. (50,0)

C.(15,0)

D. (130,0)

Ans. C

Sol. $\sigma_x = 80 \text{ MPa}$,

 $\sigma_v = -50 \text{ MPa}$

Co-ordinates of center of Mohr's circle = $[\frac{1}{2}(\sigma_x + \sigma_y), 0]$

= [(30/2),0]

= (15,0)

32. A casting of size $100 \times 50 \times 50$ cm was filled by top gates with manometric height in pouring basin to be 25 cm. find the time (in sec) to fill the casting. The area of gate is 5 square cm.

A. 225.76

B. 451.7

C. 332.8

D. 250

Ans. A

Sol. In the top gating system, Filling time is given by:

$$t_f = \frac{V_m}{v_g A_g}$$

Where:

V_m: Volume of mold

Ag: Gate area

Velocity at gate $(v_t) = \sqrt{(2gh_t)}$

Thus:
$$t_f = \frac{100 \times 50 \times 50}{5 \times \sqrt{2 \times 981 \times 25}} = 225.76 \text{ sec}$$

33. Match **List-I** (Forging/Technique) with **List-II** (Process) and select the correct answer using the code given below the lists:

List-I

- A). Smith Forging
- B). Drop Forging
- C). Press Forging
- D). Machine Forging

List-II

- 1. Material is only upset to get the desired shape
- 2. Carried out manually in open dies
- 3. Done in closed impression dies by hammers in blows
- 4. Done in closed impression dies by continuous squeezing force

A. A-2, B-3, C-4, D-1

B. A-4, B-3, C-2, D-1

C. A-2, B-1, C-4, D-3

D. A-4, B-1, C-2, D-3

Ans. A

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Sol. Smith Forging: Carried out manually in open dies

Drop Forging: Done in closed impression dies by hammers in blows

Press forging: Done in closed impression dies by continuous squeezing force

Machine Forging: Material is only upset to get the desired shape

34. A police car is chasing a thief going on a bike. The bike crosses a turning at a speed of 25 m/s. The police car follows the bike at a speed of 30 m/s, crossing the turning 12 seconds later than bike. Assume that they travel at constant speeds. The distance covered by the police car to catch up the bike from turning point is

A. 0.3 km

B. 1.5 km

C. 1.8 km

D. 0.36 km

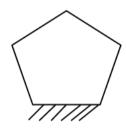
Ans. C

Sol. distance covered by the bike in $12 \text{ sec} = 12 \times 25 = 300 \text{ m}$ i.e., the police car is 300 m behind the bike.

The time taken by the police car to catch the bike = $\frac{300}{(30-25)}$ = 60 s

The distance covered by the car to catch up bike from the turning = $30 \times 60 = 1800 \text{ m} = 1.8 \text{ km}$

35. Find the mobility of the given mechanism.



A. 0

C. 2

B. 1

D. 3

Ans. C

Sol. Here,

$$n = 5$$
, $j_1 = 5$, $j_2 = 0$.

Hence,
$$m = 3(5-1)-(2\times5)-0 = 2$$

As the degree of freedom is 2,

two separate input motions are required to produce constrained motion for the mechanism.

36. Delta iron exists in the temperature range of

A. 0 °C to 768 °C

B. 768 °C to 900 °C

C. 900 $^{\circ}$ C to 1400 $^{\circ}$ C

. 1400 °C to 1530 °C

Ans. D



Sol. Delta iron, characterized by a body-centred cubic crystal structure, is stable above a temperature of 1,390 °C (2,534 °F). Below this temperature there is a transition to gamma iron, which has a face-centred cubic (or cubic close-packed) structure and is paramagnetic.

37. Which of the following sensors is used to detect non-magnetic materials?

- (a) Hall effect sensor
- (b) Proximity switches
- (c) Inductive proximity switch
- (d) Eddy current sensor

A. Only (a)

B. both (b) and (c)

C. both (a) and (c)

D. both (c) and (d)

Ans. D

Sol. Eddy current proximity sensors are used to detect non-magnetic, but conductive materials.

This comprises a coil, an oscillator, a detector, and a triggering circuit.

An inductive proximity sensor can detect metal targets approaching the sensor, without physical contact with the target. Inductive Proximity Sensors are roughly classified into the following three types according to the operating principle: the high-frequency oscillation type using electromagnetic induction, the magnetic type using a magnet, and the capacitance type using the change in capacitance.

38. What is the relationship between elastic constants E, G and K?

A.
$$E = \frac{KG}{9K + G}$$

B.
$$E = \frac{9KG}{K+G}$$

$$C. E = \frac{9KG}{KG + 3G}$$

D.
$$E = \frac{9KG}{3K + G}$$

Ans. D

Sol.

$$E = 2G(1 + \mu)$$
 ...(i)

$$E = 3k(1 - 2\mu)$$
 ...(ii)

Solving(i) & (ii)

$$\frac{E}{2G} - 1 = \left(1 - \frac{E}{3k}\right) \frac{1}{2}$$

$$\frac{E}{2G} - 1 = \frac{1}{2} - \frac{E}{6k}$$

$$E\left(\frac{1}{2G} + \frac{1}{6k}\right) = \frac{3}{2}$$

$$E\left(\frac{3k+G}{6kG}\right) = \frac{3}{2} = \frac{9kG}{3k+G}$$



- 39. Which one of the following welding processes consists of minimum heat affected zone (HAZ)?
 - A. Shielded Metal Arc Welding (SMAW)
 - B. Laser Beam Welding (LBW)
 - C. Ultrasonic Welding (USW)
 - D. Metal Inert Gas Welding (MIG)

Ans. B

- Sol. In LBW, the waves are of single phase (coherent). Thus the laser beam is a high energy source of heat to melt, even evaporate, the joint for the fusion welding in laser beam welding.
- 40. Which of the following components is not used in On-line tool monitoring system?
 - A. Dynamometer

B. Amplifier

C. Data Acquisition

D. Decision making system

Ans. D

- Sol. The on-line tool monitoring system consists of
 - 1. Dynamometer
 - 2. Amplifier
 - 3. Data acquisition system
 - 4. Signal processing
- 41. A mild steel plate has to be rolled in one pass such that the final plate thickness is $\left(\frac{2}{3}\right)^{r}$

of the initial thickness, with the entrance speed of 10 m/min and roll diameter of 500 mm. If the plate widens by 2% during rolling, the exit velocity (in m/min) is______ .

A. 12.35

B. 13.60

C. 14.71

D. 15.09

Ans. C

Sol. There is no change in metal volume at a given point per unit time throughout the process. Therefore, $b_ih_iv_i=b_fh_fv_f$

Given:
$$\frac{h_f}{h_i} = \frac{2}{3}$$

$$b_f = b_i + \frac{2}{100} \times b_i = 1.02b_i$$

Velocity at inlet: $v_i = 10 \text{ m/min}$

Thus,
$$10 \times b_i \times h_i = v_f \times 1.02 \times b_i \times \frac{2}{3} \times h_i$$

 $v_f = 14.705 \text{ m/min}$

42. Match **List-I** (Name of the invariant reaction) with **List-II** (Critical load reaction during cooling) and select the correct answer using the code given below the lists:

List-I

- [A]. Monotectic
- [B]. Eutectic
- [C]. Eutectoid
- [D]. Peritectic

List-II

- [1]. LIQUID \rightarrow SOLID₁ + SOLID₂
- [2]. $LIQUID_1 \rightarrow LIQUID_2 + SOLID$
- [3]. $SOLID \rightarrow SOLID_1 + SOLID_2$
- [4]. LIQUID + SOLID₁ \rightarrow SOLID₂
- A. A-3, B-1, C-2, D-4

B. A-2, B-4, C-3, D-1

C. A-3, B-4, C-2, D-1

D. A-2, B-1, C-3, D-4

Ans. D

Sol. Monotectic transformation

$$Liquid_1 \xrightarrow{Constant} Liquid_2 + Solid$$

Eutectic transformation

$$Liquid \xrightarrow{Constant} Solid_2 + Solid_2$$

Eutectoid transformation

$$Solid \xrightarrow{Constant} Solid_2 + Solid_2$$

Peritectic transformation

$$Solid_1 + Liquid \longrightarrow Solid_2$$

- 43. The static deflection of a shaft under a flywheel is 4 mm. Take $g = 10 \text{ m/s}^2$. What is the critical speed in rad/s?
 - A. 50

B. 20

C. 10

D. 5

Ans. A

Sol. Given,

static deflection of a shaft = 4mm= 0.004 m

Critical speed in rad/s = $\sqrt{\frac{g}{\delta}}$

$$=\sqrt{\frac{10}{4\times10^{-3}}}=50 \text{ rad/sec}$$

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44. Find the value of allowance and shaft tolerance according to hole base system if Hole:

$$47_{+0.50}^{+0.52}$$
 mm , Shaft : $47_{+0.45}^{+0.47}$ mm

A. 0.02mm, 0.03mm

B. 0.03mm, 0.02mm

C. 0.03mm, 0.03mm

D. 0.02mm, 0.02mm

- Ans. B
- Sol. Allowance = maximum metal condition of hole maximum metal condition of shaft
 - = low limit of hole high limit of shaft
 - = 47.50 47.47
 - = 0.03 mm

Shaft tolerance = high limit - low limit

- = 47.47-47.45
- = 0.02mm
- 45. An elevator weighing 1000 kg attains at upward velocity of 2 m/s in 1 second with uniform acceleration from static. The tension in (in N) the supporting cables is
 - A. 7810N

B. 8710N

C. 11810

D. 0

- Ans. C
- Sol. given,

$$M = 1000kg, V = 2m/s$$

$$t = 1sec$$

from the 1st law of motion

- V = u + at
- $2 = 0 +a \times 1$
- $a = 2m/s^2$

when the elevator is moving upward,

then

- T Mg = Ma
- $T 1000 \times 9.81 = 1000 \times 2$
- T = 11810N
- 46. Match **List-I** (type of gear failure) with **List-II** (Reasons) select the correct answer using the code given below the lists:

List-I

- A). Scoring
- B). Pitting
- C). Scuffing
- D). Plastic flow



List-II

- 1). Oil film breakage
- 2). Yielding of surface under heavy loads
- 3). Cyclic loads causing high surfaces stress
- 4). Insufficient lubrication

A. A-2, B-1, C-3, D-4

B. A-2, B-3, C-4, D-1

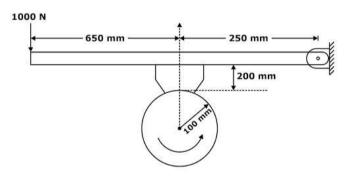
C. A-4, B-3, C-1, D-2

D. A-4, B-1, C-3, D-2

Ans. C

Sol.

- Scoring is Lubrication Failure inadequate lubrication with high tooth load and poor surface finish results in breakdown of oil film and causes metal to metal contact which is called scuffing or galling.
- Pitting=Cyclic loads causing high surfaces stress.
- Scuffing=Oil film breakage.
- Plastic flow = Yielding of surface under heavy loads
- 47. A brake drum (as shown in figure) is rotating in anticlockwise direction. Coefficient of friction between drum and shoe is 0.25 The braking torque for the shoe will be_____.



A. 50 N-m

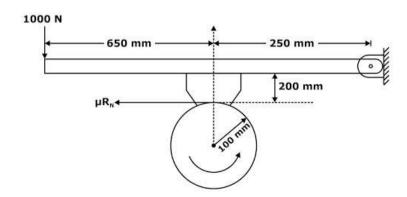
B. 75 N-m

C. 100 N-m

D. 150 N-m

Ans. B

Sol.







Taking moment about hinge,

$$\sum M_O = 0$$

$$1000 \times 900 = R_N \times 250 + F_f \times 200$$
 { $F_f = \mu R_N = 0.25 R_N$ }

1000×900=300R_N

 $R_N = 3000 N$

 $T_R = F_f \times radius$ of brake drum

 $T_R = \mu R_N \times R$

 $T_R = 3000 \times 0.25 \times 100$

- = 75000 N-mm
- = 75 N-m
- 48. The full form of the "SCARA" robot is
 - A. Search compliance assembly robot arm
 - B. Selective conformance arrangement robot arm
 - C. Selective compliance assembly robot arm
 - D. Search conformance arrangement robot arm

Ans. C

- Sol. "SCARA" full form is selective compliance assembly Robot Arm
- 49. Match the equivalent length of the column for their respective end conditions:

Column 1

- a) Both end hinged
- b) One end fixed and other free
- c) Both ends fixed
- d) One end fixed and other hinged

Column 2

- P) 2L
- Q) $\frac{L}{\sqrt{2}}$
- R) L/2
- S) L

Ans D



Sol. The equivalent length of the column for the respective end conditions are

Both ends hinged \rightarrow L

One end fixed and other free \rightarrow 2L

Both ends fixed \rightarrow L/2

One end fixed and other hinged $\rightarrow \frac{L}{\sqrt{2}}$

50. A grinding wheel is specified as 49 A 46 M 7 V 24. This grinding wheel is used for_____.

A. Roughing operation

B. Semi finishing

C. Finishing

D. None of above

Ans. B

Sol.

• The third number from the left in series represents the abrasive size. Hence 46 is the size of the abrasive.

10-24 → Roughing

24-60 → Semi finishing

 $61 - 180 \rightarrow Finishing$

Therefore this grinding wheel is used for semi finishing operation.

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