

Q. 1

GENERIC

Type Single choice

Points 1



As far as non-ferrous metals and alloys are concerned, assess the following statements

- I. titanium alloys can be used for service at 550 °C for long periods
- II. magnesium alloys are pyrophoric, i.e., a fire hazard exists when machining or sand-casting these alloys
- III. Some aluminium alloys can be hardened by heat treatment.
- IV. nickel alloys possess low strength and corrosion resistance at high temperatures

The following statements are correct:

Zoom image

- I, II and III
- I and IV
- III and IV
- I and II
- II, III and IV

Q. 2

GENERIC

Type Single choice

Points 1



With regard to the structure of metals, it is **not true** to state that

Zoom image

- hexagonal close-packed crystals have high probability of slip
- slip and twinning are the basic mechanisms that lead to plastic deformation in crystal structures
- the difference between the actual and theoretical strength of metals can be explained by dislocations
- the smaller the grain size of a metal, the higher its strength and hardness at room temperature
- the more the cold work, the lower the temperature required for recrystallization

Q. 3

GENERIC

Type Single choice

Points 1

With regard to advanced manufacturing technologies, it is **true** to state that:

Zoom image

- machine-tool structures made of granite-epoxy composite present higher damping capacity compared with gray cast iron
- high-speed steels are the most indicated tool materials for high-speed machining
- hard turning requires the use of single-point polycrystalline diamond tools
- cutting tool wear is not a relevant aspect to be considered in ultraprecision machining
- machining centers can efficiently perform distinct operations such as turning, milling and drilling

Q. 4

GENERIC

Type Single choice

Points 1

Owing to the widespread use of gears in distinct products from watches to heavy equipment, gear manufacturing plays a relevant role in the metalworking industry.

Within this scenario, assess the following statements

- I. gear hobbing is most economical for high quantity production
- II. spur gears are easier to machine than bevel gears
- III. form cutting is a fast gear manufacturing process
- IV. shaving is a relevant gear roughing process

The following statements are correct:

Zoom image

- I and II
- I and IV
- III and IV
- I, II and III
- II, III and IV

Q. 5

GENERIC

Type Single choice

Points 1

Burrs resulting from machining operations have several disadvantages and, therefore, deburring must be performed using distinct strategies depending on burr location, part complexity and labor cost, among other factors.

Within this scenario, assess the following statements.

Robotic deburring is preferable to manual deburring

BECAUSE

Robotic deburring is more consistent and eliminates manual labor

With regard to these statements, it is correct to assert

 Zoom image

- The two statements are correct and the second is a true justification of the first
- The two statements are correct, but the second is not a true justification of the first
- The first statement is true and the second is false
- The first statement is false and the second is true
- Both statements are false

Q. 6

GENERIC

Type Single choice

Points 1

Given the non-zero constants a , b , c and d , evaluate the following limit: $\lim_{x \rightarrow 0} \frac{\sin(ax^2)}{1 - \cos(bx)}$

 Zoom image

- $\frac{2a}{b}$
- ∞
- $\frac{2a}{b^2}$
- $-\frac{2a}{b^2}$
- $-\frac{2a}{b}$

Q. 7

What is the value of the area, A , between the function $f(x) = \ln(x)$ and the x -axis, from $x=1$ to $x=e$ (número de Euler, $e=2.718281828459045\dots$)?

 Zoom image

- $2e$
- $2e - 1$
- $2e + 1$
- 1
- $-2e$

Q. 8

Given the positive values a , b and c , suppose that the position, $S(t)$, of an object for $t \geq 0$ is given by $S(t) = ce^{b(a+t)}$, where t is the travel time. What is its acceleration?

 Zoom image

- $-cbe^{b(a+t)}$
- $b^2cS(t)$
- $S(t)$
- $-cS(t)$
- $b^2S(t)$

Q. 9

GENERIC

Type Single choice

Points 1 ...

Evaluate the following expression: $\int \left[\frac{1}{(x-a)(x-b)} \right] dx$

 Zoom image

- $\frac{x}{(x-a)(x-b)} + C$
- $\frac{\ln(x-a)}{a-b} + \frac{\ln(x-b)}{b-a} + C$
- $\ln \left(\frac{1}{(x-a)(x-b)} \right) + C$
- $\frac{\ln(x-a)}{a-b} - \frac{\ln(x-b)}{b-a} + C$
- $\frac{\ln \frac{x-a}{x-b}}{b-a} + C$

Q. 10

GENERIC

Type Single choice

Points 1 ...

A thermometer, reading 15°C , is brought into a room whose temperature is 31°C . Two minutes later the thermometer reading is 23°C . How long does it take until the reading is 30°C ? Consider the model given by Newton's law of cooling: $\frac{dT}{dt} = k(T - T_r)$, where k is a system constant, T_r is the room temperature and T is the thermometer temperature.

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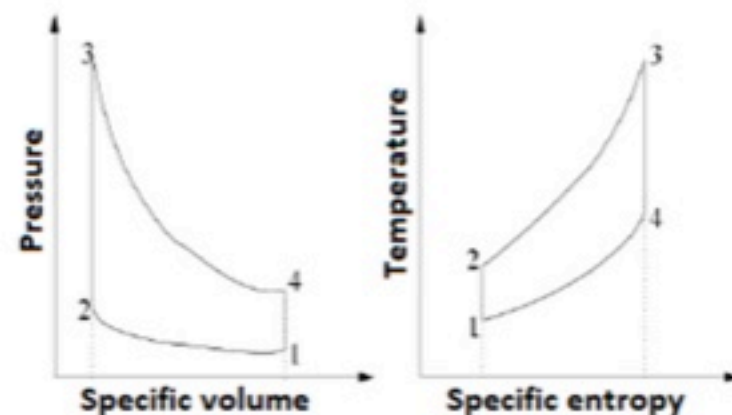
- 8 min
- 0.272 min
- 6 min
- 225 sec
- 25 min

A thermal power plant is a system that converts thermal energy into electrical energy. Identify the **incorrect** alternative regarding the operating principles of a thermal power plant.

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- The air is cooled by a heat exchanger before entering the combustion chamber.
- In the condenser, low-pressure steam is cooled until it is condensed, turning into low-temperature water.
- The high-pressure superheated steam is what drives the turbine, which is coupled to an electric generator.
- In the steam generator (boiler), water is superheated until it becomes high-pressure superheated steam.
- The water circuit that drives the turbine is closed, with no significant mass losses.

A spark-ignition engine can be approximated by an Otto cycle, whose typical Pressure vs. Specific volume and Temperature vs. Specific entropy diagrams are represented below.



Choose the **correct** option:

 Zoom image

- The fuel combustion process is represented by a constant volume heat addition. The result of this (non-isentropic) process is an increase in pressure and temperature of the air inside the cylinder.
- The process 2-3 occurs when the piston is at bottom dead center.
- The process 1-2 is an irreversible heat addition process, occurring as the piston moves from top dead center to bottom dead center.
- The presence of irreversibilities in the expansion and compression processes would cause points 2 and 4 to shift to the left of the Temperature vs. Specific entropy diagram.
- The efficiency of any Otto cycle is given by $\eta = 1 - r^{1-k}$, where r represents the volume ratio and k the specific heat ratio.

Q. 13

GENERIC

Type Single choice

Points 1

...

A perfect gas is reversibly compressed in a piston-cylinder system from 100 kPa to 200 kPa. In the initial state, the gas is at a temperature of 600 K. The compression follows a polytropic process with an exponent $n = 1/2$. Considering the perfect gas constant as $R = 2 \text{ kJ/kg.K}$, the absolute value of the specific work associated with the process is equal to:

[Zoom image](#)

- $1200 \frac{\text{kJ}}{\text{kg}}$
- $2400 \frac{\text{kJ}}{\text{kg}}$
- $1800 \frac{\text{kJ}}{\text{kg}}$
- $1000 \frac{\text{kJ}}{\text{kg}}$
- $600 \frac{\text{kJ}}{\text{kg}}$

Q. 14

GENERIC

Type Single choice

Points 1

...

A small thermoelectric power plant operates in a location where the ambient temperature is 27°C . The hot source is at 627°C and provides 0.90 MW to an engine, which produces 350 kW of work. If this machine operated on a Carnot cycle, how much smaller would the heat rejection to the environment be compared to the current rejection?

[Zoom image](#)

- 250 kW
- 300 kW
- 350 kW
- 550 kW
- 600 kW

Q. 15

GENERIC

Type Single choice

Points 1

A certain building facility operates according to the ammonia absorption thermodynamic cycle. It is **correct** to state that this facility is for:

 Zoom image

- Refrigeration
- Steam propulsion
- Heating
- Pumping
- Air compression

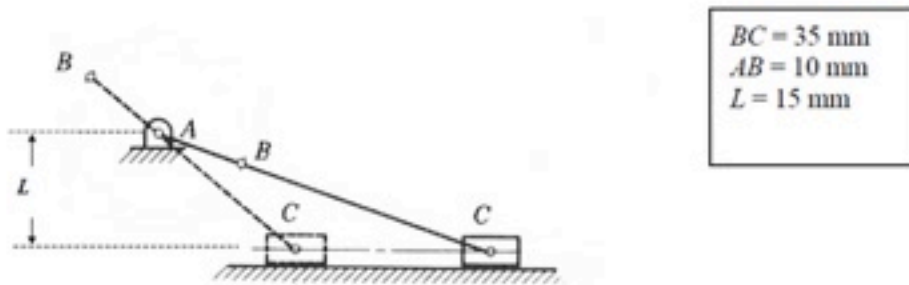
Q. 16

GENERIC

Type Single choice

Points 1

What is the value of the time ratio for the displaced slider-crank mechanism. The segment AB represents the crank and rotates around point A. The figure shows the two settings of the mechanism for zero cursor speed. The dimensions of the mechanism are given in millimeters.



 Zoom image

- 1.21
- 1.11
- 1.09
- 1.15
- 1.25

Q. 17

GENERIC

Type Single choice

Points 1 ...

Consider a four-bar linkage mechanism used in a machine to convert rotational motion into oscillating motion. The four bars are composed of a bar that receives the input rotation and an oscillating bar that represents the output movement of the mechanism, an intermediate bar and a fixed link (Ground). Regarding the theoretical functioning of four-bar articulated mechanisms, analyze the statements below and select the correct alternative:

I. The speed transmission ratio between the input and output of the four-bar mechanism is constant when the input and output bars are the same length.

II. For the four-bar mechanism to generate a continuous oscillating movement (Crank-Rocker Mechanism), the Grashof condition must be satisfied, that is, the sum of the lengths of the smallest and largest links must be smaller than the sum of the lengths of the other two links.

III. In a four-bar mechanism, if the length of the intermediate bar is equal to the sum of the lengths of the other three bars, the resulting movement in the output link will be pure translation.

Is(are) correct:

 Zoom image

- Only II.
- Only I.
- Only I, and II.
- Only II and III.
- All are incorrect.

Q. 18

GENERIC

Type Single choice

Points 1 ...

A steel rotating-beam test specimen has an ultimate strength of 1000 MPa. Estimate the life of the specimen if it is tested at a completely reversed stress amplitude of 400 MPa. Mark the right alternative below. Consider: $S_e = 290 \text{ MPa}$ and $f = 0.78$.

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- 25680 cycles
- 32480 cycles
- 45230 cycles
- 22879 cycles
- 54231 cycles

Q. 19

GENERIC

Type Single choice

Points 1 ...

A rotating solid steel shaft is loaded in bending and torsion such that $M_a = 160 \text{ N} \cdot \text{m}$, $M_m = 85 \text{ N} \cdot \text{m}$ and a constant torque of $T = 400 \text{ N} \cdot \text{m}$. With a design factor of 1.5, determine the minimum acceptable diameter of the shaft using the Gerber criterion, and mark the right alternative below.

Consider: $S_{ut} = 680 \text{ MPa}$; $S_y = 510 \text{ MPa}$; $S_e = 220 \text{ MPa}$; $k_f = 2.34$; $k_{fs} = 2.08$.

 Zoom image

32.47 mm

36.44 mm

32.50 mm

34.98 mm

31.20 mm

Q. 20

GENERIC

Type Single choice

Points 1 ...

About round-wire helical compression springs:

- i. The spring index is given by $C = D/d$ which is a measure of the coil curvature, and important to determine the stress-correction factor;
- ii. The curvature of the wire causes a localized increase in stress on the inner surface of the coil, but it is not important;
- iii. The spring rate has no dependence on the material properties;
- iv. The fundamental critical frequency should be greater than 15 to 20 times the frequency of the force or motion of the spring in order to avoid resonance with the harmonics.

The true options are:

 Zoom image

i and iv;

ii and iii;

i, iii and iv;

i, ii and iii;

all.