PROGRAMA DE PÓS-GRADUAÇÃO EM ENGENHARIA MECÂNICA

UNIVERSIDADE FEDERAL DE MINAS GERAIS

Escola de Engenharia

Prova de seleção de candidatos 2025/1

Orientações - LEITURA OBRIGATÓRIA:

- Esta prova terá duração de 120 minutos, contados a partir do horário de início de sua realização;
- A prova é composta por 20 questões de múltipla escolha com 5 opções (A, B, C, D e E);
- O candidato deve marcar uma opção por questão, somente;
- É obrigatório o preenchimento da última folha, intitulada FOLHA DE RESPOSTAS;
- A correção da prova será feita com base no que estiver apresentado na FOLHA DE RESPOSTAS, nada mais;
- Não é permitido desgrampear a prova, sob pena de desclassificação;
- Ao final da prova, é obrigatória a devolução de todas as páginas desta prova;
- É obrigatória a assinatura nesta página, confirmando a leitura destas orientações, e a concordância com o disposto;
- Todo o conteúdo da prova está em língua inglesa.

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Assinatura do candidato

Question 1

Find the limit of $\lim_{x \to 4} \frac{\sqrt{x-3} - 1}{x - 4}$

a) $\frac{1}{2}$

b) $\frac{1}{4}$

c) $\frac{1}{8}$

d) $\frac{1}{16}$

e) $\frac{1}{32}$

Question 2

Determine the value of c such that the function is continuous on the entire real number line.

$$f(x) = \begin{cases} x + 3, & x \leq 2 \\ cx + 6, & x > 2 \end{cases}$$

a) $c = -\frac{1}{4}$

b) $c = -\frac{1}{2}$

c) $c = -1$

d) $c = 1$

e) $c = \frac{1}{4}$

Question 3

A utility company burns coal to generate electricity. The cost C in dollars of removing p% of the air pollutants in the stack emissions is

$$C = \frac{80{,}000p}{100 - p}, \quad 0 \leq p < 100.$$

Find the cost of removing 15% of the pollutants.

a) $12,117.65

b) $15,117.65

c) $17,117.65

d) $14,117.65

e) $18,117.65

Question 4

Acceleration The velocity of an automobile starting from rest is

$$v(t) = \frac{90t}{4t + 10}$$

where v is measured in meters per second. Find the acceleration at 1 second, 5 seconds, and 10 seconds.

a) 0.39 m/s^2, 3 m/s^2, and 4.36 m/s^2

b) 4.59 m/s^2, 2 m/s^2, and 0.36 m/s^2

c) 0.36 m/s^2, 2 m/s^2, and 4.59 m/s^2

d) 0.36 m/s^2, 1 m/s^2, and 4.59 m/s^2

e) 4.59 m/s2, 1 m/s2, and 0.36 m/s2

Question 5

Solve the doomsday equation

$$\frac{dy}{dt} = ky^{1+\varepsilon}$$

given that $y(0) = y_0$.

a) $y = \dfrac{1}{\left[\left(\frac{1}{y_0}\right)^{\epsilon} - k\epsilon t\right]^{1/\epsilon}}$

b) $y = \dfrac{2}{\left[\left(\frac{1}{y_0}\right)^{\epsilon} - k\epsilon t\right]^{1/\epsilon}}$

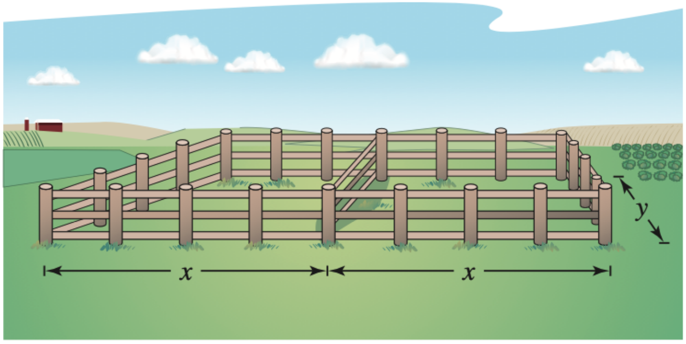
c) $y = \dfrac{2}{\left[\left(\frac{1}{y_0}\right)^{\epsilon} - k\epsilon t\right]^{2/\epsilon}}$

d) $y = \dfrac{1}{\left[\left(\frac{1}{y_0}\right)^{\epsilon} - k\epsilon t\right]^{2/\epsilon}}$

e) $y = \dfrac{1}{\left[\left(\frac{2}{y_0}\right)^{\epsilon} - k\epsilon t\right]^{1/\epsilon}}$

Question 6

A rancher has 400 meters of fencing with which to enclose two adjacent rectangular corrals (see figure). What dimensions should be used so that the enclosed area will be a maximum?



a) x = 50m; y = 66.67 m

b) x = 50m; y = 100 m

c) x = 100m; y = 50 m

d) x = 66.67 m; y = 50 m

e) x = 50m; y = 50 m

Question 7

Find $\int \tan^2 2x\, dx.$

a) $= \frac{1}{2} tan 2x - 2x + C$

b) $= \frac{1}{2} tan 2x - x + C$

c) $= tan 2x - x + C$

d) $= tan 2x - 2x + C$

e) $= tan 3x - 3x + C$

Question 8

Find $\displaystyle\int \frac{1}{1 + e^x}\,dx.$

a) $x - ln(2 + e^x) + C$

b) $x - ln(1 + e^x) + C$

c) $x - ln(1 - e^x) + C$

d) $x - ln(2 - e^x) + C$

e) $2x - ln(1 + e^x) + C$

Question 9

A thermometer, reading 30°C, is brought into a room whose temperature is 10°C. Two minutes later the thermometer reading is 20°C. How long does it take until the reading is 10.625°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.

a) 232.5 sec

b) 1.9375 min

c) 8 min

d) 10 min

e) 20 min

Question 10

A company produces x units of a product, and its profit function is given by $P(x) = -2x^2 + 40x - 100$. What is the number of units x that maximizes the profit?

a) 5

b) 10

c) 15

d) 20

e) 25

Question 11

The height $h(t)$ of an object dropped from a building is given by $h(t) = 100 - 5t^2$, where t is the time in seconds. What is the velocity of the object after 2 seconds?

a) $-10m/s$

b) $-15m/s$

c) $-72km/h$

d) $-108km/h$

e) $-144km/h$

Question 12

Find the slope of the tangent line to the curve $f(x) = x^3 - 6x^2 + 9x$ at $x = 2$.

a) -3

b) 0

c) 3

d) 6

e) 9

Question 13

A rectangular garden is to be fenced on three sides (two widths and one length) using 100 meters of fencing. The fourth side is against a wall and requires no fence. What is the maximum area of the garden?

a) $250m^2$

b) $500m^2$

c) $750m^2$

d) $1000m^2$

e) $1250m^2$

Question 14

Given $f(x) = x^4 - 4x^3 + 6x^2$ find the x-coordinate of the inflection point.

a) 4

b) 3

c) 2

d) 1

e) There is no real inflection point in this function.

Question 15

Find the area of the region bounded by the curves $y = x^2$ and $y = 2x - x^2$.

a) $1/2$

b) $2/3$

c) $1/3$

d) $4/3$

e) 1

Question 16

Find the volume of the solid obtained by rotating the region bounded by $y = \sqrt{x}$, the x-axis, and the line $x = 4$, about the x-axis.

a) 8π

b) 8

c) 16π

d) 16

e) 10

Question 17

If the velocity of a particle is given by $v(t) = \ln(t)$, what is the displacement of the particle from $t = 1$ to $t = e$?

a) 0

b) 1

c) e

d) $-e$

e) $2e$

Question 18

If the position of a particle is given by $s(t) = t^2\ln(t)$, what is the acceleration of the particle in $t = e$?

a) 0

b) 3

c) $e + 2$

d) 5

e) $3e$

Question 19

Evaluate $\lim_{x \to 0} \frac{sin(6x)}{e^{3x}-1}$?

a) 0

b) 3

c) 2

d) 6

e) 1

Question 20

A falling particle in the air hits the surface of the sea in a very deep region and is decelerated. If the velocity of the particle is given by $v(t) = \frac{3t^2+5}{7t^2+2t+1}$ where $t = 0$ is the moment the particle enters the water, what is the terminal velocity of the particle?

a) 0

b) 3

c) 7

d) 5

e) $3/7$

FOLHA DE RESPOSTAS

Número de inscrição:

Nome do candidato:

Assinatura:

01	A	B	C	D	E
02	A	B	C	D	E
03	A	B	C	D	E
04	A	B	C	D	E
05	A	B	C	D	E
06	A	B	C	D	E
07	A	B	C	D	E
08	A	B	C	D	E
09	A	B	C	D	E
10	A	B	C	D	E
11	A	B	C	D	E
12	A	B	C	D	E
13	A	B	C	D	E
14	A	B	C	D	E
15	A	B	C	D	E
16	A	B	C	D	E
17	A	B	C	D	E
18	A	B	C	D	E
19	A	B	C	D	E
20	A	B	C	D	E

FOLHA DE RESPOSTAS

Número de inscrição:

Nome do candidato:

Assinatura:

01		B	C	D	E	11	A	B		D	E
02	A		C	D	E	12		B	C	D	E
03	A	B	C		E	13	A	B	C	D	
04	A	B	C	D		14	A	B	C	D	
05		B	C	D	E	15	A	B		D	E
06		B	C	D	E	16		B	C	D	E
07	A		C	D	E	17	A		C	D	E
08	A		C	D	E	18	A	B	C		E
09	A	B	C		E	19	A	B		D	E
10	A		C	D	E	20	A	B	C	D	