Instituto Tecnológico de Aeronáutica

Programa de Pós-Graduação em Engenharia de Infraestrutura Aeronáutica
Programa de Pós-Graduação em Engenharia Aeronáutica e Mecânica

Prova de Seleção – 1º semestre de 2018 – Questões de Matemática

01 de novembro de 2017

Nome do Candidato

Observações

1. Duração da prova: 90 minutos (uma hora e meia)
2. Não é permitido o uso de calculadoras ou outros dispositivos eletrônicos
3. Cada pergunta admite uma única resposta
4. Marque a alternativa que considerar correta na tabela abaixo
5. Utilize o verso das folhas para a resolução das questões

Questão	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Resp.																

Questões em Português

1. Dois conjuntos A e B são tais que o número de elementos de $A - B$ é 27, o número de elementos de $A \cup B$ é 39 e o número de elementos da $A - B$, $A \cap B$ e $B - A$ estão em progressão geométrica. Então, o conjunto $A \cap B$ tem:

   (a) 7 elementos
   (b) 8 elementos
   (c) 9 elementos ←
   (d) 10 elementos
   (e) 11 elementos

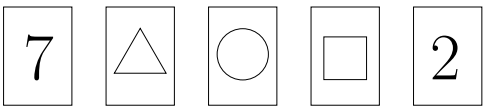

Figura 1: Baralho com números e figuras geométricas

2. Em coordenadas cartesianas, sejam $A = (7, 4)$, $B = (0, 3)$ e $C = (4, 0)$ os vértices de um triângulo ABC. A bissetriz interna do ângulo $\hat{A}$ desse triângulo intercepta o lado BC no ponto M de coordenadas, tais que:

   (a) $M = (8 - 4\sqrt{2}, 3\sqrt{2} - 3)$ ←
   (b) $M = (3\sqrt{2} - 3, 8 - 4\sqrt{2})$
   (c) $M = (6 - 3\sqrt{2}, 3\sqrt{2} - 3)$
   (d) $M = (3\sqrt{2} - 3, 3 - \sqrt{2})$
   (e) $M = (4\sqrt{2} - 3, 4 - 2\sqrt{2})$

3. Um baralho hipotético é constituído por cartas nas quais há um número natural estampado em uma das faces e uma figura geométrica estampada na outra (verso). Considere uma sequência de cartas dispostas tal como apresentado na figura 1, e a seguinte proposição: *toda carta que possui um número par em uma das faces contém um triângulo na outra (verso)*. Para verificar se as cartas dessa sequência estão de acordo com a proposição, podemos afirmar que:

   (a) É suficiente virar apenas 1 carta específica.
   (b) É suficiente virar apenas 2 cartas específicas.
   (c) É suficiente virar apenas 3 cartas específicas. ←
   (d) É suficiente virar apenas 4 cartas específicas.
   (e) Deverão ser viradas as 5 cartas.

4. A divisão de um polinômio $P(x)$ por $x^2 - x$ resulta no quociente $6x^2 + 5x + 3$ e resto $-7x$. O resto da divisão de $P(x)$ por $2x + 1$ é igual a:

   (a) 1
   (b) 2
   (c) 3
   (d) 4
   (e) 5 ←

5. Roberto e Alice estão apostando uma corrida. Como alice é mais rápida que Roberto, ela dá a ele 120 metros de vantagem. Se Alice corre a uma velocidade de 5 metros por segundo e Roberto corre a 3 metros por segundo, quantos segundos Roberto correrá antes que Alice alcance ele?

   (a) 15
   (b) 30
   (c) 40
   (d) 60 ←
   (e) 120

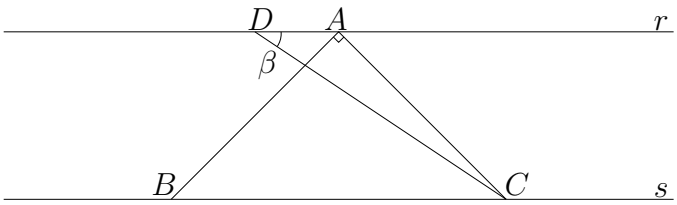

Figura 2: Triângulo retângulo isóceles e ceviana entre duas retas paralelas

6. Na figura 2, a reta r é paralela à reta s. A medida de AB é igual à medida de AC, assim como a medida de BC é igual à medida de CD. Sabendo-se que o $\hat{A}$ é um ângulo reto, então o ângulo β é igual a:

   (a) $30°$ ←
   (b) $25°$
   (c) $22°$
   (d) $15°$
   (e) $12°$

7. Seja a função $f(x) = \sqrt{3}\sin(x) + \cos(x)$, tal que $x \in \mathbb{R}$, onde x é expresso radianos. A amplitude da função e o período correspondem, respectivamente a:

   (a) $\sqrt{3}/2$; $\pi/2$
   (b) $1/2$; $\pi/2$
   (c) $1/2$; π
   (d) 2; π
   (e) 2; 2π ←

8. Marque a opção errada (ou a última opção, caso todas estejam certas):

   (a) $\ln(x^2 - 2x + 2) \geq 0 \; \forall x \in \mathbb{R}$
   (b) $3\ln(2) > 2\ln(3)$ ←
   (c) $\ln(10) > \log_\pi(10)$
   (d) $\ln(10) > \ln(\pi^2)$
   (e) todas as opções anteriores estão corretas

Questões em Inglês

9. In Figure 3, x and y are, respectively

   (a) $22.5°$ and $30°$
   (b) $30°$ and $30°$
   (c) $30°$ and $45°$ ←
   (d) $45°$ and $60°$
   (e) $60°$ and $75°$

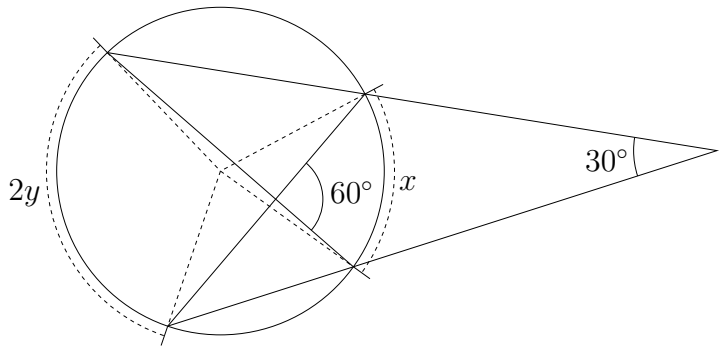

Figure 3: Circle with internal and external angles (not in scale).

10. In a collection of geometric figures, there are twelve coloured cylinders, all with the same diameter. There are four red cylinders and four yellow cylinders and they are 5 cm high. There are also two blue cylinders and two black cylinders and they are 10 cm high. In how many different ways can we stack cylinders in order to get a 20 cm cylindrical stack?

    (a) 28
    (b) 32
    (c) 36
    (d) 44 ←
    (e) 48

11. There are six different color paints and each of them should be used to paint a face of a cube. In how many different ways can these faces be painted, such that these schemes cannot produce the same color arrangement by spatial rotation of the cube?

    (a) 5
    (b) 6
    (c) 15
    (d) 30 ←
    (e) 36

12. In Figure 4, O is the center of the circle circumscribed to triangle ABC and the line $\overline{AD}$ is the bissector of the angle $\widehat{BAC}$. Mark the *false* statement (or, otherwise, the last one):

    (a) $\overline{BD} = \overline{DC}$
    (b) $\widehat{BOD} = \widehat{DOC}$
    (c) $\widehat{BAD} = \widehat{DAC}$
    (d) $\dfrac{BM}{BA} = \dfrac{CA}{CM}$ ←
    (e) all the options above are correct

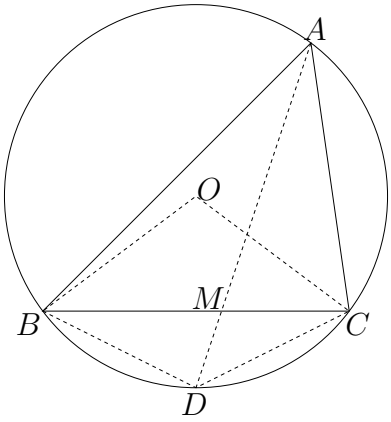

Figure 4: Triangle inscibed in a circle.

13. If $2 < p < 4$, then which of the following could be true?

(I) $p^2 < 3p$
(II) $p^2 = 3p$
(III) $p^2 > 3p$

(a) I only
(b) II only
(c) III only
(d) I and II only
(e) I, II, and III ←

14. Define $f(x)$ by the equation $f(x) = \pi/x$. Then $f\left(f(-\pi)\right) =$

(a) $-1/\pi$
(b) $-\pi$ ←
(c) $1/\pi$
(d) π^2
(e) π^3

15. Harvey runs a 30-kilometers course at a constant rate of 4 kilometers per hour. If Clyde runs the same track at a constant rate and completes the course in 90 fewer minutes, how fast did Clyde run?

(a) 4.5 kilometers per hour
(b) 5 kilometers per hour ←
(c) 6 kilometers per hour
(d) 8 kilometers per hour
(e) 10 kilometers per hour

16. Six identical machines, running continuously at the same constant rate, take 12 days to complete a shipment. How many additional machines, each running at the same constant rate, would be needed to reduce the time required to complete a shipment by 3 days?

(a) 1

(b) 2 ←

(c) 3

(d) 4

(e) 5

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Programa de Pós-Graduação em Engenharia de Infraestrutura Aeronáutica
Processo Seletivo ITA - PG-EIA - 1º semestre de 2018

Prova Escrita/Língua Inglesa

1º de novembro de 2017

Nome do Candidato

Instruções: Abaixo é apresentado um texto em inglês onde o candidato deverá efetuar sua tradução para a língua portuguesa. Não é permitida consulta, uso de dicionários ou de dispositivos eletrônicos. Duração da prova: 1 (uma) hora.

In the face of climate change can our engineers keep the trains running on time?

Engineering and maintaining railway bridges has always been difficult - climate change, however, creates a whole new level of challenge

Physicist Michio Kaku once said, "What we usually consider as impossible are simply engineering problems... there's no law of physics preventing them." And so it has been with railway and metro bridges that span waterways. The city of Washington, D.C., is bounded on two sides by rivers and an untold number of streams. Every morning the Orange Line, one of six train lines that serve the city, ferries 12,060 commuters -- per hour. And this miracle occurs every day in Berlin, Tokyo, London, Amsterdam, Shanghai, and numerous other metropolitan areas. In the United Kingdom alone there are more than 40,000 railway bridges.

Much has been written on how to maintain this infrastructure, particularly in the difficult transition zones where trains leave land to ascend bridges over water. "All railway systems suffer rapid track deterioration at the transition zones requiring high maintenance costs," said Sakdirat Kaewunruen, Ph.D., Department of Civil Engineering, University of Birmingham, United Kingdom. "In the past decades, there have been so many ad hoc solutions provided, but there has been no work on evaluating its life cycle cost and sustainability."

Each nation has employed its own methodology for maintenance and repairs, but new, daunting challenges created by climate change -- extreme heat, extreme cold, and severe flooding -- require yet more rigorous solutions.

An unprecedented study titled, "Lifecycle Assessments of Railway Bridge Transitions Exposed to Extreme Events," published in Frontiers in Built Environment, benchmarks the costs and carbon emissions for the life cycle of eight mitigation measures and reviews these methods for their effectiveness in three types of extreme environmental conditions.

Railway systems are designed for a 50-year lifespan, which is calculated on the integrity of the materials used, and most railways are built along one of two common track systems: rails set on railway ties (U.S.A.) or sleepers (UK), which are then 'ballasted' into beds of rock or gravel; or rails that are set onto concrete slabs. Sometimes both are used on one rail line with one transiting to the other. In either case, the engineering feat that must be solved is that as the train crosses the transition between ground and bridge, the relative stiffness of the bedrock, concrete, vs. metal bridge can impart intense vibrations that drastically impact the train rails and even make the ride uncomfortable to commuters. Transition zones require four to eight times more maintenance than ordinary rail tracks.

(…)

In this study, the authors provide engineering assumptions and sample calculations for their recommendations, but also stress that solutions need to be developed on a case-by-case basis, taking into account cost over the life cycle, environmental factors, and the impact high maintenance can have on the carbon footprint. Furthermore, cost of materials and of maintenance can range widely from country to country.

"Climate change is a significant issue for every industry in the world," said Kaewunruen. "Next we will analyze scenarios with multiple hazards. We have been informed that some events may come together, for example an earthquake at the same time as extreme heat, or extreme wind at the same time as extreme rainfall or runoff. Bridges respond to different events individually, but when you have multiple hazards simultaneously they can suffer even greater impacts."

Source: www.sciencedaily.com