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NPTEL

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Courses » Mathematical Methods and Techniques in Signal Processing

Announcements **Course** Ask a Question Progress FAQ

## Week 0 - Background and Prerequisites

Register for  
Certification exam

### Course outline

How to access  
the portal

#### Week 0 - Background and Prerequisites

Prerequisites  
and References

Quiz :  
Assignment 0

Assignment 0 -  
Solutions

#### Week 1 - Introduction to Signal Processing, State Space Representation and Vector Spaces - I

#### Week 2 - Vector Spaces - II

#### Week 3 - Vector Spaces - III and Signal Geometry

#### Week 4 - Probability and Random Processes

## Assignment 0

The due date for submitting this assignment has passed.

As per our records you have not submitted this **Due on 2019-01-27, 23:55 IST.**  
assignment.

Instructions:

- The following assignment is to refresh the basic topics required for the course.
- Please attempt the assignment and click "*Check Answers*" to obtain your scores.
- This assignment will not be considered for your final grade.
- The detailed solutions will be posted on 21st January 2019.
- Make sure you take the assignment **only after refreshing your basics** so that you gauge yourself correctly.
- Older browsers might show **unintended vertical bars** at the end of math equations.
- You can gauge yourself based on your scores as follows:

- 00 - 20: Not ready for the course
- 21 - 35: Need to brush up your basics
- 36 - 60: Good Score - you may have to revisit some basics during the course
- 61 - 75: Excellent Score

1) A is a  $5 \times 5$  matrix with  $\det(A) = -1$ . Compute the determinant of  $-2A$ . **1 point**

-1

1

-32

32

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

32

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Multirate Systems - II
Week 7 - Multirate Systems - III
Week 8 - Multirate Systems - IV
Week 9 - Wavelets - I
Week 10 - Wavelets - II and Continuity of Functions
Week 11 - Fourier Series - I
Week 12 - Fourier Series - II and KL Transform
Interaction Session

ce De

$3u(n - 1)$

$\sum_{k=-\infty}^{\infty} 3u(n - 1)u(n - k) - 3u(n - 2)u(n - k)$

$3u(n - 1) - 3u(n - 2)$

**No, the answer is incorrect.**  
**Score: 0**

**Accepted Answers:**  
 $3u(n - 1)$

3) Let  $\mathcal{Z}(a(n)) = A(z)$  and  $\mathcal{Z}(b(n)) = B(z)$ . What is  $B(z)$  in the system below? **1 point**

$\sum_{i=1}^k g_i H_i(z)$

$g_1 H_1(z) + g_2 H_2(z) + g_k H_k(z)$

$(H_1^{g_1}(z) + H_2^{g_2}(z) + \dots + H_k^{g_k}(z))A(z)$

$\sum_{i=1}^k g_i H_i(z)A(z)$

**No, the answer is incorrect.**  
**Score: 0**

**Accepted Answers:**  
 $\sum_{i=1}^k g_i H_i(z)A(z)$

4) Choose the causal systems. **1 point**

$y(n) = x(n)$

$y(n) = x(-n)$

$y(n) = \frac{2}{1-x(n+1)}$

$y(n) = x(n) \sin(2\pi(n + 1))$

$y(n) = \sum_{i=-\infty}^n x(i)$

**No, the answer is incorrect.**  
**Score: 0**

**Accepted Answers:**  
 $y(n) = x(n)$   
 $y(n) = x(n) \sin(2\pi(n + 1))$   
 $y(n) = \sum_{i=-\infty}^n x(i)$

5) The Z-transform of  $x[n]$  is  $X(z)$ . Compute the Z-transform of  $nx[n]$ . **1 point**

$z \frac{dX(z)}{dz}$

$$-z \frac{dX(z)}{dz}$$

$$z^{-1} \frac{dX(z)}{dz}$$

$$-z^{-1} \frac{dX(z)}{dz}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$-z \frac{dX(z)}{dz}$$

6) Which of the following cannot be a value of probability?

1 point

 0.22

 1.001

 0

 -0.1

No, the answer is incorrect.

Score: 0

Accepted Answers:

1.001

-0.1

7) Marbles numbered from 1 to 20 are mixed up and a marble is chosen at random. What is the probability that the marble drawn has a number which is a multiple of 3 or 5?

1 point

 1/2

 9/20

 2/5

 7/15

No, the answer is incorrect.

Score: 0

Accepted Answers:

9/20

8) A family has two children. What is the probability that both are boys, given that at least one is a boy? Assume that the probability of a random child being a boy or girl is 0.5.

2 points

  $\frac{1}{2}$ 
  $\frac{1}{3}$ 
  $\frac{1}{4}$ 
 none of the above

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\frac{1}{3}$

9) Which of the following are bases for  $\mathbb{R}^2$ ?

2 points

$$\{(1, 0), (2, 2)\}$$

$$\{(1, 0), (1, 1), (0, 1)\}$$

$$\{(1, 1), (2, 2)\}$$

$$\{(1, 1), (1, -1)\}$$

$$\{(1, -1)\}$$



No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\{(1, 0), (2, 2)\}$$

$$\{(1, 1), (1, -1)\}$$

10) Three companies  $A, B, C$  manufacture light bulbs and have a market share in the ratio  $0.35 : 0.35 : 0.3$ . Probability of each of them producing a defective bulb is  $0.01, 0.02$  and  $0.05$  respectively. A randomly chosen bulb is found defective. What is the probability it was manufactured by company  $B$ ?

2 points

$$\frac{7}{20}$$

$$\frac{14}{51}$$

$$\frac{7}{51}$$

$$\frac{7}{40}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\frac{14}{51}$$

11) Which of the following functions are linear with respect to the variable in the bracket?

2 points

$$\sin \theta \quad (\theta)$$

$$a \cos \phi \quad (a)$$

$$\frac{c}{d} \quad (d)$$

$$(a + b)^2 - (a - b)^2 \quad (b)$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$a \cos \phi \quad (a)$$

$$(a + b)^2 - (a - b)^2 \quad (b)$$

12)

2 points

Find the eigenvalues of the matrix  $\begin{bmatrix} -5 & 0 & 2 & 3 \\ 0 & 1 & 4 & 2 \\ 0 & 0 & 3 & 6 \\ 0 & 0 & 0 & 5 \end{bmatrix}$  ?

- $-1, 1, 3, 5$
- $1, 1, 3, 5$
- $-5, 1, 3, 5$
- $5, 1, 3, 5$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$-5, 1, 3, 5$

13) True or False : Given  $\bar{x}$  is an eigenvector corresponding to the eigenvalue  $\lambda$  of the matrix  $\mathbf{A}$ . Then the eigenvalue and eigenvector of  $\mathbf{A}^3$  is  $\lambda^3$  and  $3\bar{x}$ .

2 points

- True
- False

No, the answer is incorrect.

Score: 0

Accepted Answers:

False

14) Let  $x$  and  $y$  be two positive numbers. What is the probability that  $2x + 6y$  is even?

2 points

- 0
- 0.5
- 0.75
- 1

No, the answer is incorrect.

Score: 0

Accepted Answers:

1

15) Let  $A$  and  $B$  be two matrices of size  $n \times n$  such that  $\det(AB) = 0$  and  $\det(A) \neq 0$ , then

2 points

- all the eigenvalues of  $B$  must be zero.
- none of the eigenvalues of  $B$  must be zero.
- at least one of the eigenvalues of  $B$  must be zero.
- $B$  should be a zero matrix.

No, the answer is incorrect.

Score: 0

**Accepted Answers:**

*at least one of the eigenvalues of  $B$  must be zero.*

16) If  $A$  is a real square matrix, then  $AA^T$  is

**2 points**

- asymmetric
- sometimes symmetric
- always symmetric
- skew-symmetric

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*always symmetric*

17) Out of 6 positive and 8 negative numbers, four numbers are chosen and multiplied. What is the probability that the product is a negative number?

**2 points**

- 101/1001
- 505/1001
- 500/1001
- 496/1001

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*496/1001*

18) From a shuffled pack of 52 cards, 13 cards are dealt. What is the probability that it contains exactly one king, given that it contains exactly two jacks? Give your answer to two decimal places.

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*(Type: Range) 0.43,0.45*

**3 points**

19) Let  $S = \{u, v, w\}$  be a linearly independent set. For what value(s) of  $k$  is the set  $S_1 = \{v - u, kw - v, u - w\}$  also linearly independent?

**3 points**

- 
- $k \neq 1$
- 
- $k = 1$
- 
- $k \neq 0$
- 
- $k = 0$

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*$k \neq 1$*

*$k = 0$*

20) Let  $A \in \mathbb{C}^{n \times n}$ . If  $A^2 = A$ , what are the eigenvalues of  $A$ ?

**3 points**

- 0 and 1 only
- 1 only
- 0, 1 and -1 only
- not possible to determine from given data

No, the answer is incorrect.

Score: 0

Accepted Answers:

0 and 1 only

21) Which of the following represents the signal with  $Z$  transform as  $\frac{6z}{z^2 - 12z + 35}$ ?

3 points

- $(7^n - 5^n)$
- $u(n - 7) - u(n - 5)$
- $3(7^n - 5^n)u(n)$
- $\sin(\frac{\pi}{6}n)u(n)$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$3(7^n - 5^n)u(n)$

22) Consider the finite field  $\mathbb{F}_3$  that comprises of elements 0, 1 and 2. The field operations are given in the tables below: **3 points**

Which of the following vectors in  $\mathbb{F}_3^3$  can be obtained as superposition of  $u_1 = [2 \ 1 \ 0]^T$  and  $u_2 = [1 \ 0 \ 0]^T$ ?

- $u_3 = [3 \ 1 \ 0]^T$
- $u_4 = [1 \ 2 \ 0]^T$
- $u_5 = [2 \ 2 \ 0]^T$
- $u_6 = [2 \ 1 \ 1]^T$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$u_4 = [1 \ 2 \ 0]^T$

$u_5 = [2 \ 2 \ 0]^T$

23) Which of the following conditions should the variables  $a, b, c, d, e$  and  $f$  satisfy for the **3 points**

matrix  $A = \begin{bmatrix} a & b & 0 \\ 0 & 0 & c \\ d & e & f \end{bmatrix}$  to be invertible?

- $c \neq 0$
-

$$f \neq 0$$

$$a \neq d, b \neq e \text{ and } f \neq c$$

$$bd \neq ae$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$c \neq 0$$

$$bd \neq ae$$

24)

Which of the following condition should  $x$  satisfy for matrix  $B = \begin{bmatrix} 3 & 1 & 1 \\ 0 & 1 & x \\ 0 & 1 & 2 \end{bmatrix}$  to have

3 points

all eigenvalues to be real?

$$x = 0$$

$$x \leq 0$$

$$x \geq -0.25$$

$$x \geq -10$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$x \geq -0.25$$

$$x \geq -10$$

25) Let  $H(z) = \frac{2}{1-0.7z^{-1}} + \frac{1}{1-4z^{-1}}$  be the impulse response of a LTI system. What is the ROC of  $H(z)$  if the system is causal? 3 points

$$|z| < 0.7$$

$$|z| > 0.7$$

$$|z| < 4$$

$$|z| > 4$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$|z| > 4$$

26) True or False: Upsampler  $y(n) = x\left(\frac{n}{L}\right)$  is a LTI system. 3 points

True

False

No, the answer is incorrect.

Score: 0

Accepted Answers:



False

27) True or False: If atleast one of the eigenvalues of a matrix is zero, then the matrix is not invertible. **3 points**

- True  
 False

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

True

28) Consider a real skew-symmetric matrix of size  $n \times n$  where  $n$  is odd. Then **3 points**

- Columns of the matrix are linearly independent.  
 Columns of the matrix are linearly dependent.  
 Matrix is invertible.  
 Matrix is full rank.

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

Columns of the matrix are linearly dependent.

29) Let  $x = [1, 2, \dots, 50]^T$  be a column vector of size  $50 \times 1$ . Then the rank of the matrix  $xx^T$  is **3 points**

- 50  
 25  
 1  
 0

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

1

30) 50 people are waiting in a queue to board an airplane. The first person has lost his boarding ticket and sits on a random seat. The next person takes his/her own seat if it is available, else chooses a random seat. This process continues for the rest of the passengers. What is the probability that the last passenger will be able to sit on his/her original seat? **4 points**

- $\frac{1}{50}$   
  
  $\frac{1}{50^2}$   
  
  $\frac{1}{2}$   
  
  $\frac{1}{25}$

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

$\frac{1}{2}$

31)

What is the energy of the signal  $g(t)$  whose frequency spectrum is given by  $G(f) = \text{sinc}^2(f) + e^{-j5\pi f} \text{sinc}(f)$ ? Write your answer rounded off to 2 decimal places, without the unit.

Hint

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) 1.66,1.68



4 points

32] Let

$\mathcal{Z}(a(n)) = A(z)$ ,  $\mathcal{Z}(x(n)) = X(z)$ ,  $\mathcal{Z}(h_1(n)) = H_1(z)$  and  $\mathcal{Z}(h_2(n)) = H_2(z)$ . Which of the following form a Z transform pair?




$u(n)$  and  $\frac{z}{1-z}$

$2\delta(n-1) + 3nu(n)$  and  $\frac{5z^2+4z+2}{z(z+1)^2}$

$a(n) * (g_1h_1(n) + g_2h_2(n))$  and  $g_1A(z)H_1(z) + g_2A(z)H_2(z)$

$y(n) = \begin{cases} x(n/3) & n \bmod 3 = 0 \\ 0 & \text{else} \end{cases}$  and  $\frac{1}{3}X(z^3)$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$2\delta(n-1) + 3nu(n)$  and  $\frac{5z^2+4z+2}{z(z+1)^2}$

$a(n) * (g_1h_1(n) + g_2h_2(n))$  and  $g_1A(z)H_1(z) + g_2A(z)H_2(z)$

Previous Page

End