

# Self Assessment Test: Profile Communication Systems

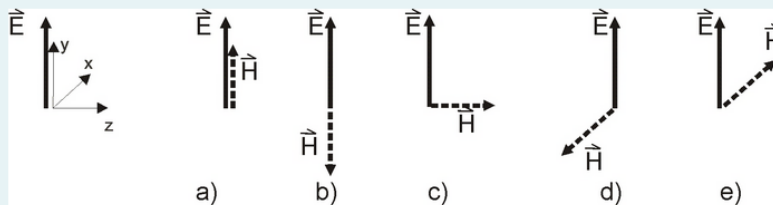
This is the Online Self Assessment for perspective students of the Master program *Communication Systems and Networks (CSN)*, study profile *Communication Systems*.

The assessment contains 16 questions. You have 90 minutes. Try to answer the questions.

You should not use any reference materials, tools or online resources! You will find the answers on the last page.

## Q1

A vertically polarized TEM wave propagates towards positive z-direction. Given is the vector of the electric field as shown on the left picture. Which picture a) - e) below shows the correct direction of the corresponding vector of the magnetic field?



Select one:

- a)
- b)
- c)
- d)
- e)

## Q2

Determine the rank of the following real matrix  $A$  :

Time left 1:26:32

$$A = \begin{pmatrix} 2 & 3 & 0 & 1 \\ -1 & 0 & 1 & 3 \\ -1 & 0 & 1 & 3 \end{pmatrix}$$

Answer:

## Q3

$$\int \cos(\pi x) dx =$$

Select one:

- $C \cdot \sin(\pi x)$
- $\frac{1}{\pi} \sin(\pi x) + C$
- $\sin(\pi x) + C$
- $\cos(\frac{\pi}{2}x^2) + C$
- $\pi \sin(x) + C$

#### Q4

An impedance  $Z_S = 25 + j25\Omega$  is connected at one end to an air filled transmission line with characteristic line impedance  $Z_L = 50\Omega$  and length  $l = \lambda/2$ . What is the impedance  $Z$  into the other end of the transmission line ?

Select one:

- $Z = 25\Omega$
- $Z = (25 - j25)\Omega$
- $Z = 25 + j25\Omega$
- $Z = 50\Omega$
- $Z = (50 - j50)\Omega$
- $Z = (50 + j50)\Omega$

#### Q5

An standard audio signal of single sided bandwidth  $W = 20$  kHz is to be sampled. Which is the minimum sampling rate  $f_s$  (in kHz) necessary to synthesize the original signal from its samples without loss of information?

Answer:

#### Q6

A random variable  $z$  is generated as the sum of a zero mean gaussian random variable  $n$  with variance  $\sigma_n^2$  and a constant  $a$ , i.e.,  $z = n + a$ . How big is the probability  $P(z > a)$  ?

Select one:

- $P(z > a) = 0$
- $P(z > a) = 0.5$
- $P(z > a) = 1$
- $P(z > a) = 0.33$

#### Q7

Which of the following signals are energy signals (signals with finite energy)?

Select one or more:

- $x(t) = \text{rect}(t/5T_0)A \cos(2\pi f_0 t)$  where  $\text{rect}(x)$  is a rectangular shape with width and height equal to 1.
- $x(t) = A \cos(2\pi f_0 t)$
- $x(t) = \sigma(t)A \exp(-at)$  with  $a > 0$ .
- $x(t) = \cos(2\pi f_0 t) + \cos(2\pi f_1 t)$

#### Q8

A coaxial cable is filled with a dielectric with relative permittivity of  $\epsilon_r = 4$ . What is the propagation speed  $v_p$  of a signal on the cable ?

Select one:

- $v_p = 0.25 c_0$
- $v_p = 0.5 c_0$
- $v_p = c_0$
- $v_p = 2 c_0$
- $v_p = 4 c_0$

### Q9

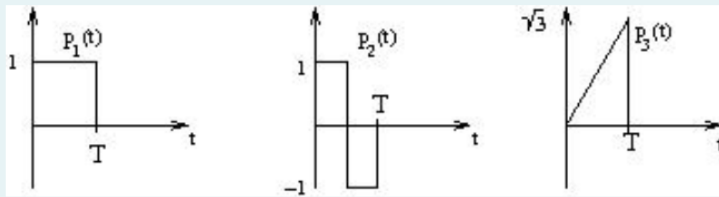
Given is a generator with open source voltage  $V_0 = 5V$  and source impedance  $Z_S = (25 - j25)\Omega$ . A resistor with  $R = 50\Omega$  is connected to the generator. What is the dissipated power  $P$  in the load resistor  $R$  ?

Select one:

- P=50 mW
- P=100 mW
- P=111 mW
- P=200 mW
- P=222 mW

### Q10

Which of the shown pulse shapes result in the maximum signal-to-noise ratio at sampling time assuming transmission via an AWGN channel and a matched filter receiver?



Select one or more:

- $p_2(t)$
- $p_1(t)$
- $p_3(t)$

### Q11

A fair dice is thrown twice. What is the probability that the sum of dots (pips) from both attempts is greater than 10 ?

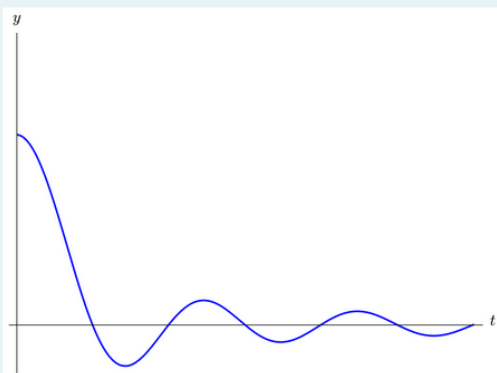
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Select one:

- $p = 1/12$
- $p = 1/3$
- $p = 0$
- $p = 1/6$

### Q12

Which of the following functions  $y = f(t)$  has the graph given below ?



$a > 0$  is a real parameter.

Select one:

- $f(t) = \cos(at)$
- $f(t) = e^{-at}$
- $f(t) = \frac{\sin(at)}{at}$
- $f(t) = \frac{a}{t}$

### Q13

A transistor amplifier has the small signal S-parameter  $S_{21} = 2.5 e^{j90^\circ}$ . What is the corresponding correct statement ?

Select one:

- The input impedance of the transistor =  $2.5 \Omega$ .
- The output impedance has a 90 degree phase shift to the input impedance.
- The reverse transmission factor of the amplifier = 0.4.
- The gain of the amplifier is 8 dB.
- The amplifier is unconditionally stable.

### Q14

A car moves with a speed of 10 meters per second into the direction of a transmit antenna, which uses a transmit frequency of  $f = 900$  MHz. Which frequency shift  $\Delta f$  in Hz will be measured due to the Doppler effect? (velocity of light:  $c = 3 \cdot 10^8$  m/s)

Answer:

### Q15

A PAM transmission scheme uses rectangular pulse shapes with amplitude -5V, -3V, -1V, 1V, 3V and 5V. How many rectangular impulses must be transmitted to carry 5 bit of information?

Answer:

### Q16

Compute the Fourier transform  $X(f)$  of the function  $x(t) = \frac{1}{T} \sigma(t) \exp(-t/T)$  where  $\sigma(t)$  is the unity step function. Which of the following terms gives the correct solution?

Select one or more:

- $X(f) = \frac{1}{1+j2\pi fT}$
- $X(f) = 1 + j2\pi fT$
- $X(f) = \frac{1}{1+2\pi fT}$
- $X(f) = \frac{T}{1+j2\pi fT}$

Solutions:

Q1 d); Q2 2; Q3 b); Q4) c); Q5 40 kHz; Q6 b); Q7 a), c); Q8 b); Q9 b); Q10 all; Q11 a); Q12 c);  
Q13 c); Q14 30 Hz; Q15 2; Q16 a)