SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 Exam Questions – 3 Groups]

G5A – Reactance; inductance; capacitance; impedance; impedance matching

G5A01 What is impedance?

The opposition to the flow of current in an AC circuit page 4-21

G5A02 What is reactance?

Opposition to the flow of alternating current caused by capacitance or inductance page 4-19

G5A03 Which of the following causes opposition to the flow of alternating current in an inductor?

Reactance page 4-19

G5A04 Which of the following causes opposition to the flow of alternating current in a capacitor?

Reactance page 4-19

G5A05 How does an inductor react to AC?

As the frequency of the applied AC increases, the reactance increases page 4-20

G5A06 How does a capacitor react to AC?

As the frequency of the applied AC increases, the reactance decreases page 4-19

G5A07 What happens when the impedance of an electrical load is equal to the output impedance of a power source, assuming both impedances are resistive?

The source can deliver maximum power to the load page 4-22

G5A08 What is one reason to use an impedance matching transformer?

To maximize the transfer of power page 4-23

G5A09 What unit is used to measure reactance?

Ohm page 4-19

G5A10 Which of the following devices can be used for impedance matching at radio frequencies?

All these choices are correct - A transformer; A Pi-network, & A length of transmission line page 4-23

G5A11 Which of the following describes one method of impedance matching between two AC circuits?

Insert an LC network between the two circuits page 4-23

SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 Exam Questions – 3 Groups]

G5B – The decibel; current and voltage dividers; electrical power calculations; sine wave root-mean-square (RMS) values; PEP calculations

G5B01 What dB change represents a factor of two increase or decrease in power?

Power DB = 10 LOG (Change in Power)

Power DB = 10 * LOG (2)

Power DB = 10 * 0.3010299957

Power DB = 3.010299957 dB

Approximately 3 dB page 4-2

G5B02 How does the total current relate to the individual currents in each branch of a purely resistive parallel circuit?

It equals the sum of the currents through each branch page 4-15

G5B03 How many watts of electrical power are used if 400 VDC is supplied to an 800 ohm load?

E
I | R **I = E / R** volts = amperes * ohms

P
I | E **P = E * I** watts = volts * amperes

P = E * (E / R)

P = (E * E) / R watts = (volts * volts) / ohms

P = (400 * 400) / 800

P = 16000 / 800

P = 200 watts

200 watts page 4-1

G5B04 How many watts of electrical power are used by a 12 VDC light bulb that draws 0.2 amperes?

P
I | E **P = E * I** watts = volts * amperes

P = 12 * 0.2

P = 2.4 watts

2.4 watts page 4-2

G5B05 How many watts are dissipated when a current of 7.0 milliamperes flows through a 1250 ohm resistance?

7.0 milliamperes = 0.007 amperes

1.25 Kilohms = 1,250.0 Ohms

E I | R	**E = I * R**	volts = amperes * ohms
P I | E	**P = E * I**	watts = volts * amperes
	P = (I * R) * I	
	P = (I * I) * R	watts = amperes * amperes * ohms
	P = (.007 * .007) * 1250	
	P = .000049 * 1250	
	P = 0.06125	watts

0.06125 watts = 61.25 milliwatts

Approximately 61 milliwatts page 4-2

G5B06 What is the output PEP from a transmitter if an oscilloscope measures 200 volts peak-to-peak across a 50 ohm dummy load connected to the transmitter output?

	Peak = Peak-to-Peak / 2	volts peak =volts p-p / 2
	Peak = 200 / 2	
	Peak = 100	Volts AC
	E = Peak * 0.707	volts dc = volts ac * 0.707
	E = 100 * 0.707	
	E = 70.7	Volts DC
E I | R	**I = E / R**	amperes = volts / ohms
P I | E	**P = E * I**	watts = volts * amperes
	P = E * (E / R)	
	P = (E * E) / R	watts = volts * volts / ohms
	P = (70.7* 70.7) / 50	
	P = 4998.49 / 50	
	P = 99.9698	watts

100 watts page 4-7

SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 Exam Questions – 3 Groups]

G5B07 What value of an AC signal produces the same power dissipation in a resistor as a DC voltage of the same value?

The RMS value page 4-5

G5B08 What is the peak-to-peak voltage of a sine wave with an RMS voltage of 120.0 volts?

E = Peak * 0.707	**Peak = E * 1.414**	volts ac = volts dc * 1.414
	Peak = 120 * 1.414	
	Peak = 169.68	volts peak
Peak = Peak-to-Peak / 2	**Peak-to-Peak = Peak * 2**	volts p-p = volts peak * 2
	Peak to Peak = 169.68 * 2	
	Peak-to-Peak = 339.36	volts p-p

339.4 volts page 4-6

G5B09 What is the RMS voltage of a sine wave with a value of 17 volts peak?

Peak = E * 1.414	**E = Peak * 0.707**	volts dc = volts ac * 0.707
	E = 17 * 0.707	
	E = 12.019	volts

12 volts page 4-6

G5B10 What percentage of power loss would result from a transmission line loss of 1 dB?

Percentage Power Passing = 100% * anti log (dB / 10)

Percentage Power Passing = 100% * 10^(dB / 10)

Percentage Power Passing = 100% * 10^(-1 / 10)

Percentage Power Passing = 100% * (10^-0.1)

Percentage Power Passing = 79.43282347%

Percentage Power Loss = 100% – Percentage Power Passing

Percentage Power Loss = 100% – 79.43282347%

Percentage Power Loss = 20.56717653%

20.6 percent page 4-3

SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 Exam Questions – 3 Groups]

G5B11 What is the ratio of peak envelope power to average power for an unmodulated carrier?

1.00 page 4-7

G5B12 What would be the RMS voltage across a 50 ohm dummy load dissipating 1200 watts?

E I | R	**I = E / R**	amperes = volts / ohms
P I | E	**E = P / I**	volts = watts / amperes
	E = P / (E / R)	
	E = (P * R) / E	
	E * E = P * R	
	E = Square Root (P * R)	volts = square root (watts * ohms)
	E = Square Root (1,200 * 50)	
	E = Square Root (60,000)	
	E = 244.9489743	

245 volts page 4-7

G5B13 What is the output PEP of an unmodulated carrier if an average reading wattmeter connected to the transmitter output indicates 1060 watts?

The ratio of peak envelope power to average power for an unmodulated carrier is 1.

1060 watts page 4-7

G5B14 What is the output PEP from a transmitter if an oscilloscope measures 500 volts peak-to-peak across a 50 ohm resistive load connected to the transmitter output?

	Peak = Peak-to-Peak / 2	volts peak = volts p-p / 2
	Peak = 500 / 2	
	Peak = 250	volts ac
	E = Peak * 0.707	volts dc = volts ac * 0.707
	E = 250 * 0.707	
	E = 176.75	volts
E I | R	**I = E / R**	amperes = volts / ohms
P I | E	**P = E * I**	watts = volts * amperes
	P = E * (E / R)	
	P = (E * E) / R	watts = (volts * volts) / ohms
	P = (176.75 * 176.75) / 50	
	P = 31240.5625 / 50	
	P = 624.81125	watts

625 watts page 4-7

SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 Exam Questions – 3 Groups]

G5C – Resistors, capacitors, and inductors in series and parallel; transformers

G5C01 What causes a voltage to appear across the secondary winding of a transformer when an AC voltage source is connected across its primary winding?

Mutual inductance page 4-13

G5C02 What happens if a signal is applied to the secondary winding of a 4:1 voltage step-down transformer instead of the primary winding?

The output voltage is multiplied by 4 page 4-14

G5C03 Which of the following components increases the total resistance of a resistor?

A series resistor page 4-15

G5C04 What is the total resistance of three 100 ohm resistors in parallel?

Resistors in Parallel, All Resistor with same unit of measurement:

Resistors in Parallel: $R = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4}}$ ohms = reciprocal of the sum of the reciprocals

$R = \frac{1}{\frac{1}{100} + \frac{1}{100} + \frac{1}{100}}$ input is in ohms

$R = \frac{1}{\frac{3}{100}}$

$R = \frac{100}{3}$

R = 33.333333 output is in ohms

33.3 ohms page 4-17

G5C05 If three equal value resistors in series produce 450 ohms, what is the value of each resistor?

Series: R * 3 = 450	**R = 450 / 3**	**R = 150**
Parallel: R / 3 = 50	**R = 50 * 3**	**R = 150**

150 ohms page 4-18

SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 Exam Questions – 3 Groups]

G5C06 What is the RMS voltage across a 500-turn secondary winding in a transformer if the 2250-turn primary is connected to 120 VAC?

E secondary = E primary * (Turns secondary / Turn primary)

E secondary = 120 * (500 / 2,250) input is in volts

E secondary = (120 * 500) / 2,250

E secondary = 60,000 / 2,250

E secondary = 26.66666666667 output is in volts

26.7 volts page 4-14

G5C07 What is the turns ratio of a transformer used to match an audio amplifier having 600 ohm output impedance to a speaker having 4 ohm impedance?

Turns Ratio = Square Root (Impedance primary / Impedance secondary)

Turns Ratio = Square Root (600 / 4)

Turns Ratio = Square Root (150)

Turns Ratio = 12.24744871

12.2 to 1 page 4-22

G5C08 What is the equivalent capacitance of two 5.0 nanofarad capacitors and one 750 picofarad capacitor connected in parallel?

750 picofarads = 0.750 nanofarads

Capacitance in Parallel, All Capacitors with same unit of measurement:

Capacitors in Parallel: **C total = C1 + C2 + C3 + C…** capacitance = sum of all capacitors

C total = 5.000 + 5.000 + 0.750 input is in nanofarads

C total = 10.750 output is in nanofarads

10.750 nanofarads page 4-18

SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 Exam Questions – 3 Groups]

G5C09 What is the capacitance of three 100 microfarad capacitors connected in series?

Capacitance in Series, All Capacitors with same unit of measurement:

Capacitors in Series: $C = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \frac{1}{C4}}$ farad = reciprocal of the sum of the reciprocals

$C = \frac{1}{\frac{1}{100} + \frac{1}{100} + \frac{1}{100}}$ input is in microfarad

$C = \frac{1}{\frac{3}{100}}$

$C = \frac{100}{3}$

$C = 33.333333$ output is in microfarads

33.3 microfarads page 4-17

G5C10 What is the inductance of three 10 millihenry inductors connected in parallel?

Inductors in Parallel, All Inductors with same unit of measurement:

Inductors in Parallel: $L = \frac{1}{\frac{1}{L1} + \frac{1}{L2} + \frac{1}{L3} + \frac{1}{L4}}$ henrys = reciprocal of the sum of the reciprocals

$L = \frac{1}{\frac{1}{10} + \frac{1}{10} + \frac{1}{10}}$ input is in millihenry

$L = \frac{1}{\frac{3}{10}}$

$L = \frac{10}{3}$

$L = 3.3333333$ output is in millihenry

3.3 millihenries page 4-17

SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 Exam Questions – 3 Groups]

G5C11 What is the inductance of a 20 millihenry inductor connected in series with a 50 millihenry inductor?

Inductors in Series, All Inductors with same unit of measurement:

Inductors in Series: **L total = L1 + L2 + L3 + L…** inductance = sum of all inductors

L total = 20 + 50 input is in millihenry

L total = 70 output is in millihenry

70 millihenries page 4-17

G5C12 What is the capacitance of a 20 microfarad capacitor connected in series with a 50 microfarad capacitor?

Two Capacitance in Series, Both Capacitors with same unit of measurement:

Capacitors in Series: $C = \frac{1}{\frac{1}{C1} + \frac{1}{C2}}$ farad = reciprocal of the sum of the reciprocals

$C = \frac{1}{\frac{C2}{C1 * C2} + \frac{C1}{C2 * C1}}$

$C = \frac{1}{\frac{C1 + C2}{C1 * C2}}$

Two Capacitors in Series: $C = \frac{C1 * C2}{C1 + C2}$ farad = product divided by sum

$C = \frac{20 * 50}{20 + 50}$ input is in microfarad

$C = \frac{1000}{70}$

C = 14.28571429 output is in microfarad

14.3 microfarads page 4-17

SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 Exam Questions – 3 Groups]

G5C13 Which of the following components should be added to a capacitor to increase the capacitance?

A capacitor in parallel page 4-15

G5C14 Which of the following components should be added to an inductor to increase the inductance?

An inductor in series page 4-15

G5C15 What is the total resistance of a 10 ohm, a 20 ohm, and a 50 ohm resistor connected in parallel?

Resistors in Parallel, All Resistors with same unit of measurement:

Resistors in Parallel:

$$R = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4}}$$

ohms = reciprocal of the sum of the reciprocals

$$R = \frac{1}{\frac{1}{10} + \frac{1}{20} + \frac{1}{50}}$$

input is in ohms

$$R = \frac{1}{\frac{1 * 10}{10 * 10} + \frac{1 * 5}{20 * 5} + \frac{1 * 2}{50 * 2}}$$

$$R = \frac{1}{\frac{10}{100} + \frac{5}{100} + \frac{2}{100}}$$

$$R = \frac{1}{\frac{17}{100}}$$

$$R = \frac{100}{17}$$

R = 5.882352941 output is in ohms

5.9 ohms page 4-18

SUBELEMENT G5 – ELECTRICAL PRINCIPLES [3 Exam Questions – 3 Groups]

G5C16 Why is the conductor of the primary winding of many voltage step-up transformers larger in diameter than the conductor of the secondary winding?

To accommodate the higher current of the primary page 4-14

G5C17 What is the value in nanofarads (nF) of a 22,000 picofarad (pF) capacitor?

Pico = 10^{-12} Nano = 10^{-9}
Convert Pico to Nano is to Convert 10^{-12} to 10^{-9} is to Divide by 3
(-12) – (-9) = -3
To Divide by 3 is to Move the Decimal Point 3 Places to the Left

22,000 picofarads = 22**.**000 nanofarads

22 nfd page 4-13

G5C18 What is the value in microfarads of a 4700 nanofarad (nF) capacitor?

Nano = 10^{-9} Micro = 10^{-6}
Convert Nano to Micro is to Convert 10^{-9} to 10^{-6} is to Divide by 3
(-9) – (-6) = -3
To Divide by 3 is to Move the Decimal Point 3 Places to the Left

4,700 nanofarads = 4**.**700 microfarads

4.7 mfd page 4-13