This product has been updated to incorporate all changes shown in the comments on the webpage and email comments as of April 1, 2020. If you have purchased this product prior to this date and wish for the latest version then please email Justin Kauwale at contact@engproguides.com or you can use this document to see the changes that were made.

The following changes have recently been incorporated

On page 8 of Mathematics,

The "i" constant also follows the factoring rules.

$$(x + yi) * (w + zi) = (xw - yz) + (wy + xz)i$$

In the state diagram, state A with the incoming arrow represents the initial state. States C and E with the double circle represent the accepting states. In other words, the program will start at state A and accepts strings that end at states C or E.

For input string 11010, the program will flow through the states A→B→C→D→E→C

For input string 10011, the states are A→B→B→C→B

For input string 0011, the states are A→D→A→B→C

For input string 01001, the states are A→D→E→ C→ D→ E

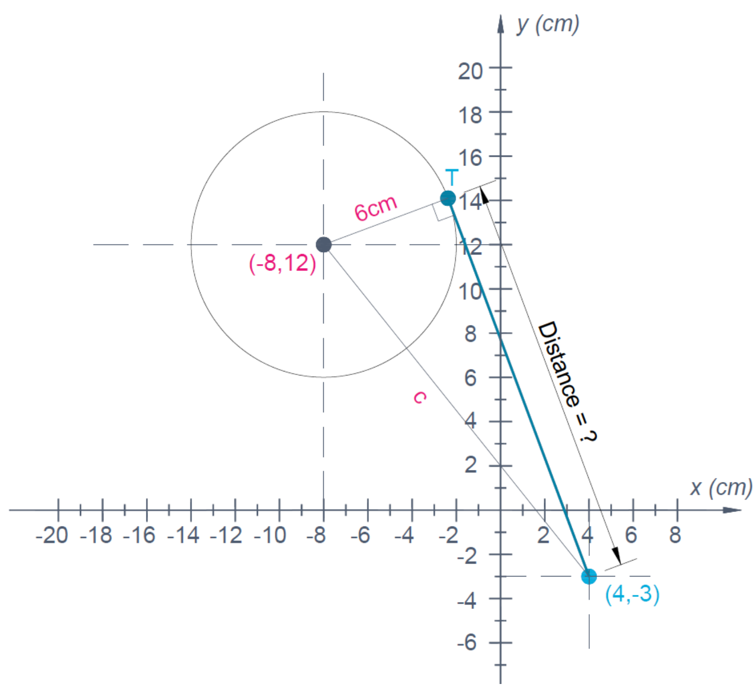
The only string that does not terminate at accepting states C or E is string 10011. Therefore, the string is not accepted.

The correct answer is most nearly, (b) 10011.

11.12 SOLUTION 12 - ANALYTIC GEOMETRY

COMPLETE SOLUTION:

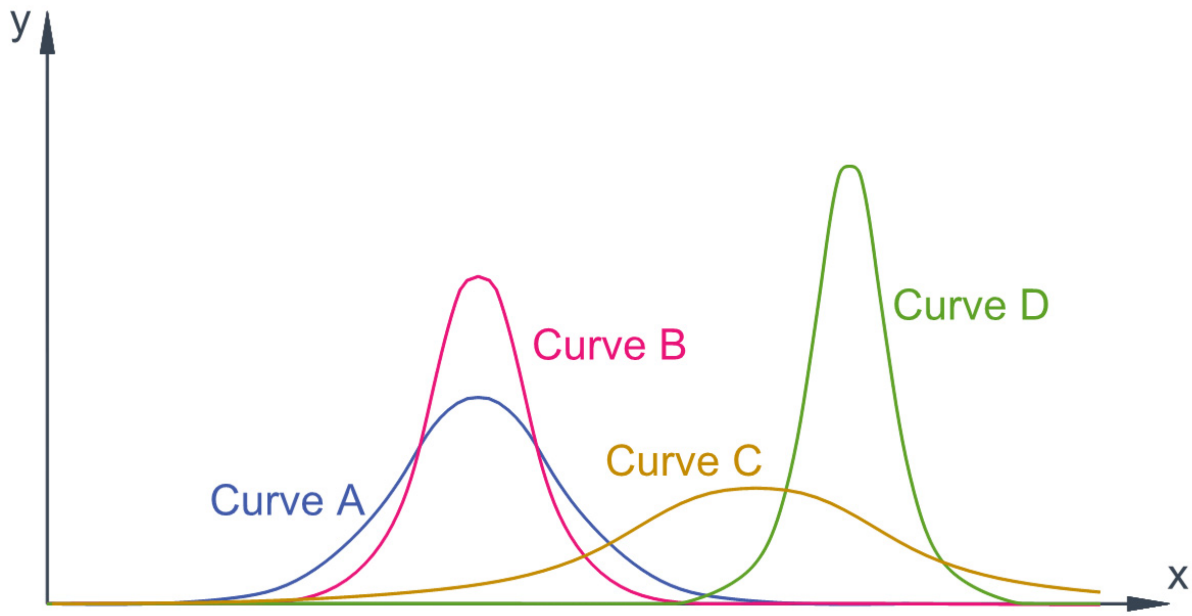
The diagram below represents the problem, which is to find the distance from point (4, -3) to point T. To solve this problem, draw the triangle that connects the circle center point to point T and to point (4, -3). By definition of a tangent line, the line from the center point to point T will be perpendicular to point (4, -3).



The short leg of this triangle is given as the radius, 6cm. The hypotenuse of the triangle can be found by solving for the distance between two points: center point (-8,12) and (4, -3), which is essentially the Pythagorean Theorem. Solve for c.

5.3 Practice Problem 3 – Probability Distribution

Answer the questions with the following options: *Curve A, Curve B, Curve C, Curve D, Unknown*



Which curve has the smallest variance? ________

Which curve has the largest mean? _______

Which curve has the largest standard deviation? ________

Which curve has the smallest mode? ________

5.4 Practice Problem 4 – Geometric Mean

Temperature differentials measured across a coil over the past 6 months were recorded as: 22F, 30F, 32F, 36F, 37F, and 40F. Find the geometric mean of these measurements.

(A) 32F

(B) 33F

(C) 34F

(D) 35F

8.0 PRACTICE EXAM PROBLEMS

8.1 PRACTICE EXAM PROBLEM 1 – ELECTRICAL FORCE

Two parallel charged plates have a voltage difference of 75 V. What is the force acting on an electron, located at one of the charged plates? The distance between the plates is 1 cm.

(a) $1.2\ x\ 10^{-15}\ N$

(b) $7.3\ x\ 10^{-16}\ N$

(c) $9.0\ x\ 10^{-17}\ N$

(d) $1.6\ x\ 10^{-19}\ N$

8.2 PRACTICE EXAM PROBLEM 2 – ELECTRIC FIELD

There are two point charges, -5.0 μC and +2.0 μC. These charges are located 17.0 cm apart. What is the magnitude of the combined electric field at a point located equidistance between the two charges?

(a) 3,000,000 V/m

(b) 5,200,000 V/m

(c) 8,700,000 V/m

(d) 9,800,000 V/m

9.0 Practice Exam Solutions

9.1 Practice Exam Solution 1 – Electrical Force

Two parallel charged plates have a voltage difference of 75 V. What is the force acting on an electron, located at one of the charged plates? The distance between the plates is 1 cm.

For this problem, you need to first find the electric field between the two plates.

$$E = \frac{V}{d} = \frac{75\ V}{1\ x\ 10^{-2}\ m} = 7{,}500\frac{V}{m}\ or\ 7{,}500\frac{N}{C}$$

Next, use the force equation to find the force acting on the electron. The charge of an electron is given in the NCEES FE Reference Handbook.

$$F = QE = 1.6\ x\ 10^{-19}\ C * 7{,}500\frac{N}{C} = 1.2\ x\ 10^{-15}\ N$$

The correct answer is most nearly, (a) $1.2\ x\ 10^{-15}\ N$

9.2 Practice Exam Solution 2 – Electric Field

There are two point charges, -5.0 µC and +2.0 µC. These charges are located 17.0 cm apart. What is the magnitude of the combined electric field at a point located equidistance between the two charges?

The electric fields created by these two charges will be pointing in the same direction. Imagine the negative charge located on the left and the positive charge located on the right. The electric field due to the negative charge will point towards itself. The electric field due to the positive charge will point away from itself, which means it will point towards the negative charge.

Next, use the equation in the NCEES FE Reference Handbook to calculate the magnitudes of these electric fields and add their magnitudes together.

$$E_{-5} = \left| \frac{-5.0\ x\ 10^{-6}\ C}{4\pi * \left(8.85\ x\ 10^{-12}\frac{F}{m}\right) * (8.5\ x\ 10^{-2}\ m)^2} \right| = 6{,}222{,}702\frac{V}{m}$$

$$E_2 = \left| -\frac{2.0\ x\ 10^{-6}\ C}{4\pi * \left(8.85\ x\ 10^{-12}\frac{F}{m}\right) * (8.5\ x\ 10^{-2}\ m)^2} \right| = 2{,}489{,}080\frac{V}{m}$$

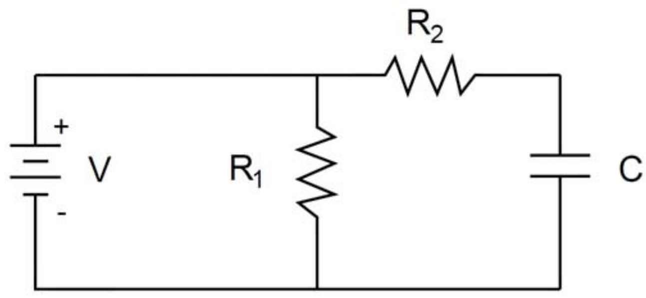
$$E_{combined} = E_{-5} + E_2 = 8{,}711{,}782\frac{V}{m}$$

The correct answer is most nearly, (c) 8,700,000 V/m

9.3 Practice Exam Solution 3 – Capacitance

What is the energy stored in the capacitor at steady state?

$$V = 30\,V; R_1 = 10\,\Omega;\; R_2 = 10\,\Omega;\; C = 250\,x\,10^{-6}\,F;$$



The first step is to find the capacitor energy equation in your NCEES FE Reference Handbook.

$$U = \frac{1}{2}CV_c^2$$

This equation shows you that you need to find the voltage across the capacitor at steady state. You can use your Circuit Analysis skills to find the voltage across the capacitor. But the key is that after a long period of time, the capacitor will behave like an open circuit. No current will flow through the circuit that contains R_2 and C. But the voltage across that "open circuit" will be the same as the voltage across R_1.

$$V_c = 30\,V$$

Now, plug-in the values to the energy equation.

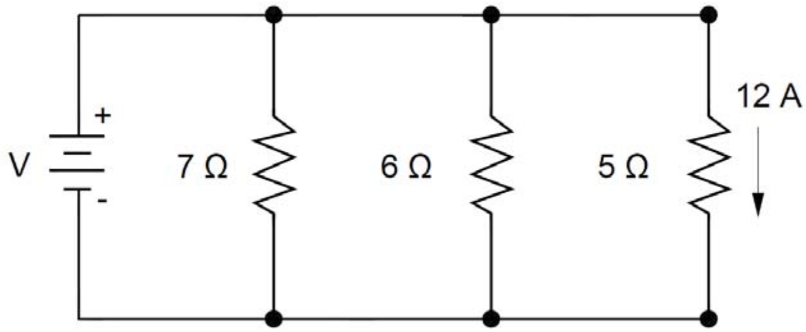
$$U = \frac{1}{2} * (250\,x\,10^{-6}\,F) * (30\,V)^2 = 0.1125\,J$$

The correct answer is most nearly, (a) 0.11 J

9.4 Practice Exam Solution 4 – Inductance

What is the energy stored in the inductor at steady state?

$$V = 30\,V; R_1 = 10\,\Omega;\; R_2 = 10\,\Omega;\; L = 20\,x\,10^{-6}\,H;$$



Since, all of the resistors are in parallel, the voltage drop across each one is the same. The voltage drop can be found through Ohm's law.

$$V = 12\ A * 5\ \Omega = 60\ V$$

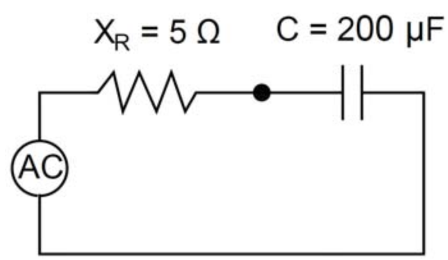
Now, apply that same voltage with Ohm's law on the 7 ohm resistor.

$$60\ V = I\ A * 7\ \Omega \rightarrow I = 8.6\ A$$

The correct answer is most nearly, **(a) 8.6 A.**

9.7 Practice Exam Solution 7 – Impedance

What is the equivalent impedance of the following circuit? The frequency is 60 Hz.



In order to find the equivalent impedance, you need to first assign the angle to each of the impedances.

$$Z_r = 5\angle 0°;$$

$$f = 60\ Hz = \frac{\omega}{2\pi} \rightarrow \omega = 377\ radians$$

$$Z_c = \frac{1}{j\omega C} = \frac{1}{j * 377\ radians * (200\ x\ 10^{-6})} = -13.3j;$$

The total impedance is found by adding the two values in series.

$$Z_{eq} = Z_r + Z_c = 5 - 13.3j$$

2.4 TUNNELING

In the study of semiconductors, which is discussed in the Electronics section, tunneling describes the process of electrons passing through an insulating layer. This will be discussed in more detail in the Electronics section.

2.5 ENERGY BANDS

Each semiconductor (semi-metals) will have an energy band. The energy band will characterize the conductivity of a material. Please see page 382 of the FE Handbook. This page has the conductivity of a semiconductor material. The conductivity is a function of the electron and hole mobility characteristics. It characterizes how well a material carries charges, which describes the material's conductivity. If no impurities are added to the material, then what is being described is an intrinsic semiconductor. The material properties for intrinsic semiconductors are not provided in the handbook. The material properties for doped semiconductors (extrinsic) are provided on page 98. This will be discussed in more detail in the Electronics section.

2.6 DOPING BANDS

When impurities are added to semiconductors, the process is called doping. The doping allows you to create either n-type or p-type semiconductors, which is discussed in more detail in the Electronics section. These extrinsic semiconductors have energy bands (energy levels) that correspond to an electric potential with units of eV. These values are shown on page 98 of the FE Handbook. The addition of the group V elements will create p-type (positive charge) semiconductors and the addition of group III elements will create n-type (negative charge). This will be discussed in more detail in the Electronics section.

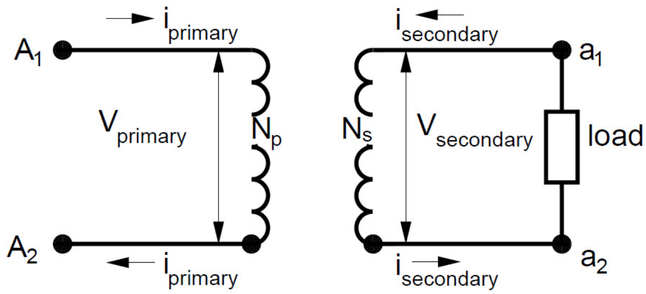
2.7 CHEMICAL PROPERTIES

The information you need to complete the problems on chemical properties of electrical materials can be found in the *NCEES FE Reference Handbook* – Chemistry Section.

There are a few chemical terms that you should be familiar with to make it easier and quicker to complete these few problems.

Cathode is where reduction occurs, which means it gains electrons. By definition, the movement of electrons is the opposite of current flow, so current flows away from the cathode. The cathode has the positive potential. Corrosion does not occur at the positive potential (i.e. voltage).

Anode is where oxidation (also known as rusting) occurs, which means it loses electrons. Current flows to the anode, which means the anode has the negative potential. The metal with the most negative potential (voltage) will corrode.



For this problem, you need to find the secondary voltage.

$$V_{secondary} = 2{,}000\ V * \left(\frac{75\ turns}{100\ turns}\right) = 1{,}500\ V$$

Now, you can find the current on the secondary side with the given load, with Ohm's law.

$$1{,}500\ V = I * (50\ \Omega) \rightarrow \mathrm{I} = 30\ \mathrm{A}$$

Finally, use the turn's ratio to find the primary current.

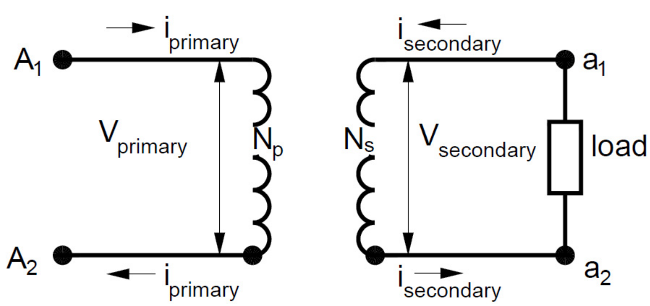
$$I_{primary} = 30\ A * \left(\frac{1500}{2000}\right) = 22.5\ A$$

The correct answer is most nearly, **(a) 20 A.**

9.5 PRACTICE EXAM SOLUTION 5 - TRANSFORMERS

A single phase transformer is shown below. Find the secondary current.

$$N_P = 50\ turns; N_S = 200\ turns; load = 10\ \Omega; I_{primary} = 10\ A;$$



$$I_{secondary} = 10\ A * \left(\frac{50}{200}\right) = 2.5\ A$$

The correct answer is most nearly, **(a) 2.5 A.**

7.0 Practice Exam Problems

7.1 Practice Exam Problem 1 – Electrostatics/Magnetostatics

There are two point charges (10 C & 20 C). The distance between the two charges is 2×10^{-3} m. The charges are in air. What is the force between the two charges?

(a) 4.0×10^{14} N

(b) 9.0×10^{14} N

(c) 4.0×10^{17} N

(d) 9.0×10^{17} N

7.2 Practice Exam Problem 2 – Electrostatics/Magnetostatics

What is the force between a point charge (10 C) and a line charge with a density of -20 C/m. Assume the line charge is infinitely long. The perpendicular distance between the point and the line is 5×10^{-2} m. Assume the medium between the two charges is air.

(a) -7.19×10^{12} N

(b) -7.19×10^{13} N

(c) -3.60×10^{12} N

(d) -3.60×10^{13} N

7.3 Practice Exam Problem 3 – Maxwell Equations

What is the strength of the magnetic field produced at 1 meter from a wire that has a current of 20,000 amperes? Assume the medium is air.

(a) 0.004 T

(b) 0.009 T

(c) 0.017 T

(d) 0.1 T

8.0 PRACTICE EXAM SOLUTIONS

8.1 PRACTICE EXAM SOLUTION 1 – ELECTROSTATICS/MAGNETOSTATICS

There are two point charges (10 C & 20 C). The distance between the two charges is 2 x 10^{-3} m. The charges are in air. What is the force between the two charges?

For this problem you need the permittivity of air and the equation that calculates the force between two point charges.

$$\varepsilon_{air} = 8.85\ x\ 10^{-12}\frac{F}{m}\ (Fe\ Reference\ Handbook)$$

$$F = \frac{Q_1 Q_2}{4\pi\varepsilon_{air} r^2} a_{r,1-2}$$

$$F = \frac{(10\ C) * (20\ C)}{4\pi * \left(8.85\ x\ 10^{-12}\frac{Coulomb^2}{N - m^2}\right) * (2\ x\ 10^{-3}\ m)^2} = 4.49\ x\ 10^{17}\ N$$

The correct answer is most nearly, **(c) 4.0 x 10^{17} N.**

8.2 PRACTICE EXAM SOLUTION 2 - ELECTROSTATICS/MAGNETOSTATICS

What is the force between a point charge (10 C) and a line charge with a density of -20 C/m. Assume the line charge is infinitely long. The perpendicular distance between the point and the line is 5 x 10^{-2} m. Assume the medium between the two charges is air.

For this problem you need the permittivity of air and the equation to calculate the electric field for a line charge. This equations are in your FE Reference Handbook.

$$Line\ charge\ electric\ field \rightarrow E = \frac{\rho_L}{2\pi\varepsilon r}$$

$$E = \frac{-20\frac{C}{m}}{2\pi * \left(8.85\ x\ 10^{-12}\frac{Coulomb^2}{N - m^2}\right) * (5\ x\ 10^{-2}\ m)} = -7.19\ x\ 10^{12}\frac{N}{C}$$

Now multiply this electric field by the point charge (10 C) to get the force.

$$F = QE = -7.19\ x\ 10^{12}\frac{N}{C} * 10\ C = -7.19\ x\ 10^{13}\ N$$

The correct answer is most nearly, **(b) -7.19 x 10^{13} N.**

6.3 Practice Exam Problem 3 – Fourier Transform

What is the Fourier transform of the following function?

$$x(t) = \sin(7t + 4)$$

(a) $e^{j4}\delta\left(f - \frac{7}{2\pi}\right) + e^{j4}\delta\left(f - \frac{7}{2\pi}\right)$

(b) $e^{j4}\delta\left(f - \frac{7}{2\pi}\right) - e^{j4}\delta\left(f - \frac{7}{2\pi}\right)$

(c) $\frac{1}{2j}\left[e^{j4}\delta\left(f - \frac{7}{2\pi}\right) + e^{j4}\delta\left(f - \frac{7}{2\pi}\right)\right]$

(d) $\frac{1}{2j}\left[e^{j4}\delta\left(f - \frac{7}{2\pi}\right) - e^{-j4}\delta\left(f + \frac{7}{2\pi}\right)\right]$

6.4 Practice Exam Problem 4 – Amplitude Modulation

The following signal is the result of amplitude modulation. What is the total normalized power of the modulated signal at 7500 rad/s? Assume a resistor of 1 ohms.

$$V = 25\sin(5000t) + 7.5\sin(2500t)\sin(5000t)$$

(a) 0.4 W

(b) 4 W

(c) 7 W

(d) 25 W

8.5 PRACTICE EXAM PROBLEM 5 - FILTERS

A series RLC band-pass filter is required to have a low cutoff frequency of 4.9 MHz and a high cutoff frequency of 5.1 MHz. What is the inductance? Assume the capacitance is 100 pF.

(a) 1×10^{-5} H

(b) 5×10^{-5} H

(c) 3×10^{-4} H

(d) 9×10^{-4} H

8.6 PRACTICE EXAM PROBLEM 6 - FILTERS

A series RLC band-pass filter is required to have a low cutoff frequency of 4.9 MHz and a high cutoff frequency of 5.1 MHz. What is the resistance? Assume the capacitance is 100 pF.

(a) 0.15 ohms

(b) 2 ohms

(c) 13 ohms

(d) 340 ohms

(b) 5 x 10^-5^ H

(c) 3 x 10^-4^ H

(d) 9 x 10^-4^ H

9.6 Practice Exam Solution 6 – Filters

A series RLC band-pass filter is required to have a low cutoff frequency of 4.9 MHz and a high cutoff frequency of 5.1 MHz. What is the resistance? Assume the capacitance is 100 pF.

For this problem, you can use the bandwidth and center frequency equations. Center frequency is the same as the resonant frequency.

$$BW = 5.1\ MHz - 4.9\ MHz = 200{,}000\ Hz$$

$$f_{res} = 5.0\ MHz = 5{,}000{,}000\ Hz$$

Now that you have the bandwidth and resonant frequency values, you should use the bandwidth equation to solve for the resistance and the previously solved inductance value.

$$f_{res} = 5{,}000{,}000\ Hz = \frac{1}{2\pi}\frac{1}{\sqrt{LC}}$$

$$f_{res} = 5{,}000{,}000\ Hz = \frac{1}{2\pi}\frac{1}{\sqrt{L(100\ x\ 10^{-12})}}$$

$$L = 1.01\ x\ 10^{-5}\ H$$

$$BW\ (\frac{rad}{s}) = \frac{R}{L}$$

$$200{,}000 * (2pi) = \frac{R}{1.01\ x\ 10^{-5}}$$

$$R = 12.7\ ohms$$

The correct answer is most nearly, (c) 13 ohms.

(a) 0.15 ohms

(b) 2 ohms

(c) 13 ohms

(d) 340 ohms

$$\mathcal{F}\{\sin(2\pi ft+\theta)\} = \frac{1}{2j}[e^{j\theta}\delta(f-f_0) - e^{-j\theta}\delta(f+f_0)$$

$$\mathcal{F}\{\sin(7t+4)\} = \frac{1}{2j}[e^{j4}\delta\left(f-\frac{7}{2\pi}\right) - e^{-j4}\delta\left(f+\frac{7}{2\pi}\right)]$$

The correct answer is most nearly, (d) $\frac{1}{2j}[e^{j4}\delta\left(f-\frac{7}{2\pi}\right) - e^{-j4}\delta\left(f+\frac{7}{2\pi}\right)]$**.**

(a) $e^{j4}\delta\left(f-\frac{7}{2\pi}\right) + e^{j4}\delta\left(f-\frac{7}{2\pi}\right)$

(b) $e^{j4}\delta\left(f-\frac{7}{2\pi}\right) - e^{j4}\delta\left(f-\frac{7}{2\pi}\right)$

(c) $\frac{1}{2j}[e^{j4}\delta\left(f-\frac{7}{2\pi}\right) + e^{j4}\delta\left(f-\frac{7}{2\pi}\right)]$

(d) $\frac{1}{2j}[e^{j4}\delta\left(f-\frac{7}{2\pi}\right) - e^{-j4}\delta\left(f+\frac{7}{2\pi}\right)]$

7.4 Practice Exam Solution 4 – Amplitude Modulation

The following signal is the result of amplitude modulation. What is the total normalized power of the modulated signal at 7500 rad/s?

$$V = 25\sin(5000t) + 7.5\sin(2500t)\sin(5000t) \ \ (Volts)$$

For this problem, you need to put the given equation into the same format as the amplitude modulated wave. This way you can find the modulation frequency and the carrier frequency and the other properties.

$$s(t) = A_c\sin(2\pi f_c t) + \frac{A_m}{2}cos(2\pi f_m t - 2\pi f_c t) - \frac{A_m}{2}cos(2\pi f_m t + 2\pi f_c t)$$

In order to solve this problem, you need the below trigonometry properties.

$$Trigonometry\ Identity \rightarrow 2\sin(A)\sin(B) = \cos(A-B) - \cos(A+B)$$

$$25sin(5000t) + \frac{7.5}{2}\cos(2500t - 5000t) - \frac{7.5}{2}\cos(2500t + 5000t)$$

$$25sin(5000t) + \frac{7.5}{2}\cos(-2500t) - \frac{7.5}{2}\cos(7500t)$$

Next, find the RMS voltage for the 7500 rad/s frequency.

$$V_{rms\ @\ 7500} = \frac{3.75}{\sqrt{2}} = 2.65\ V$$

When you plug in the ratio of the square of the voltages, then through the logarithmic properties, the square can be removed from within the log function and can be multiplied by the 10 value.

$$y - axis\ (Voltage\ equation) \rightarrow DB = 10\log_{10}\left(\frac{V_2}{V_1}\right)^2 = 20\log_{10}\left(\frac{V_2}{V_1}\right)$$

3.2 BODE PHASE PLOT

The phase plot is the time response of the control system due to changes in frequency. The control system will cause the plot to either lag or lead by a time factor. Since, the signals are cyclical; the time units used are either degrees or radians. A 360 degree phase change indicates that the signal has no change in the time component. A 180 degree phase change indicates that the signal lags or leads the original by half a cycle (360 degrees is a full cycle). A 120 degree phase change indicates that the signal lags or leads by 1/3 of a cycle.

3.3 SKETCHING BODE PLOTS

There are four main steps that you need to know, in order to sketch a bode-plot by hand. The first step is to write the transfer function in the correct format.

3.3.1 Step 1 - Formatting

The lowest order term in both the numerator and denominator must have a constant of 1.

$$H(s) = \frac{50s - 20}{s^2 - 9s}$$

The lowest order term in the numerator is 20 and the lowest term in the denominator is -9s. Next, remove the factors "20" in the numerator and a "-9" in the denominator.

$$H(s) = \frac{20 * (\frac{50}{20}s + 1)}{-9(\frac{1}{9}s^2 - \frac{9}{9}s)} = -\frac{20}{9} * \frac{(\frac{50}{20}s + 1)}{(-\frac{1}{9}s^2 + 1s)}$$

3.3.2 Step 2 - Determine the Poles, Zeros and Constants

The constant is simply the factor in the front of the function. The poles are the values of "s" that make the denominator equal to zero. The zeros are the values of "s" that make the numerator equal to zero.

In the previous example, the constant is -20/9.

$$Constant = -\frac{20}{9} = -2.22$$

The zeros occur when the numerator is equal to zero. Since this is a first order polynomial, there should be only one zero.

$$Zeros \rightarrow \frac{50}{20}s - 1 = 0$$

$$Zeros \rightarrow s = \frac{20}{50} = 0.4$$

The poles occur when the denominator is equal to zero. Since this is a second order polynomial, there should be two poles.

$$Poles = -\frac{1}{9}s^2 + 1s = s(-\frac{1}{9}s + 1)$$

$$Poles = 0 \,\&\, 9$$

3.3.3 Step 3 - Draw the Bode Diagram Parts

Draw the Constant

The first part that you must draw is the constant. On the bode-magnitude plot, this simply looks like a horizontal line across all frequencies.

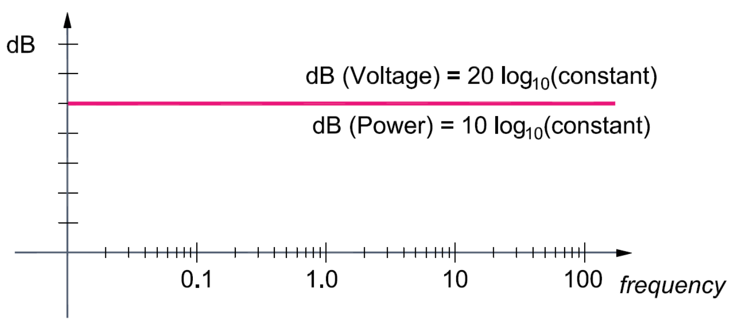


Figure 5: When you draw the constant on the plot, make sure you convert to decibels. The conversion will depend on whether your control system is in terms of voltage or power.

A negative constant will cause a 180 degree phase shift in the bode-phase plot.

Draw the Zeros & Poles that Occur at Origin

Poles will have a downward sloping line at a slope of -20 dB/decade. Zeros will have an upward sloping line at a slope of +20 dB/decade. These lines will cross the x-axis at a frequency of 1.

Random access memory or RAM is the memory that is used for reading/writing. It is used as the main memory to run programs. This memory is also volatile, so all the information is lost when the computer is shut down.

RAM along with ROM comprise the primary memory. The secondary memory is the hard drive (C-drive), which was previously discussed.

4.2 Read Only Memory (ROM)

Read-only memory (ROM) is the memory system that contains information that cannot be changed and can only be read. It is non-volatile, which means this information is not lost when the computer is turned off. This memory system holds permanent information like the boot-up programming. This memory system is also very small, on the order of megabytes.

4.3 Cache

A cache is a memory system that is faster than the primary memory system. The cache can be accessed faster and is also smaller than the primary memory system. The cache system works with the primary memory system to read and write input data and retrieval requests. In its basic form, the processor will check the cache for data and if the data is in the cache, then it will access or write to the cache, instead of accessing or writing to the primary memory system. The cache will store frequently used programs and data, so the computer can run faster. The cache is typically physically located on the processor or is a part of the processor or very close to the processor.

Cache Entry/Hit: A cache hit occurs when data is requested by the processor and the data is found in the cache memory. This allows for faster access to memory.

Cache Miss: A cache miss occurs when data is requested by the processor and the data is not found in the cache memory. When this occurs, the processor must access the primary memory system.

Latency: After a cache miss, data must be accessed from the primary memory. The time required to retrieve this data will cause latency to increase. If data is not in the cache, it will take longer to retrieve.

Cache Size: The cache is made up of sets and blocks. The way data is placed into the cache is called the placement policy. The placement determines the set associativity.

$$C\ (bytes) = S * A * B$$

$$S = number\ of\ sets; A = set\ associativity, B = block\ size\ (bytes)$$

4.4 Placement Policy

Is-Associated-With (Association): An association is a relationship between classes, where instances can be found in both classes.

Aggregation (Type of Association): An aggregation relationship is a type of relationship between classes. An aggregation example would be a microchip that can be used in any laptop model.

Composition (Type of Association): A composition relationship occurs when one class is a sub-component of the overall class. For example, a laptop key is part of the laptop keyboard.

6.0 SOFTWARE TESTING

The following testing methods can be used to test the complexity and thus speed of the software.

6.1 MCCABE'S CYCLOMATIC COMPLEXITY

McCabe's Cyclomatic complexity is governed by the below equation, where you find the number of nodes, edges and paths of a code section. It measures the complexity of the code, it also shows all the paths that need to be tested in the code. Basically, whenever there is an "IF statement", a certain number of paths can be created in the code. If there are two paths then there is one IF statement, that produces one path as True and one path as False.

$$c = e - n + 2$$

$$c = complexity, e = \#\, of\ edges; n = \#\, of\ nodes;$$

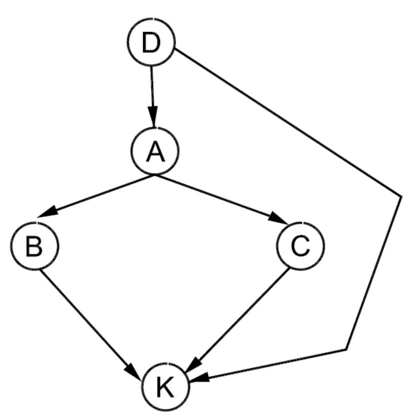


Figure 34: In this chart, there are 5 nodes and 6 edges. The complexity of this chart is equal to 3.

Another way to look at complexity is to count the number of decisions and add one. At node "D" you have to make a decision and node "A" you have to make a decisions, so the number of decisions is 2 and the complexity is 3.

10.5 Practice Exam Problem 5 – K-Map

Provide the simplified Boolean algebra function for the following.

$$F\{A,B,C,D\} = \sum_m m(\sout{0,}\,1,2,6,7)\,; \quad Assume\ the\ format\ ABCD;$$

(a) $\bar{B}$

(b) $\bar{A}$

(c) $A.B$

(d) $B + A$

10.6 Practice Exam Problem 6 – K Map

Provide the simplified Boolean algebra function for the following K-map.

	AB			
C	00	01	11	10
0	1	0	1	1
1	0	1	1	0

(a) $\bar{B}$

(b) $BC + AB$

(c) $\overline{BC} + \bar{A}BC + AB$

(d) $\overline{ABC} + \bar{A}BC + ABC$

10.7 PRACTICE EXAM PROBLEM 7 – K MAP

What is the Boolean algebra equation for the following truth table?

A	B	C	O
F	F	F	T
F	F	T	F
F	T	F	T
F	T	T	T
T	F	F	F
T	F	T	F
T	T	F	T
T	T	T	T

(a) $\overline{ABC} + B$

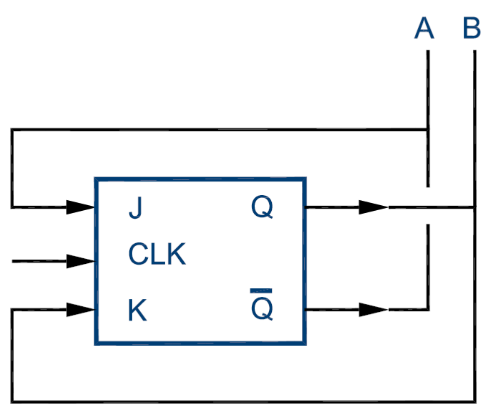
(b) $BC + AB$

(c) $ABC + AC$

(d) B

10.8 PRACTICE EXAM PROBLEM 8 – FLIP FLOP

What are the values of A & B after 2 clock impulses? Assume AB currently equals 10.



(a) 00

(b) 01

(c) 11

(d) 10

(d) $\overline{ABC} + \bar{A}BC + ABC$

11.7 Practice Exam Solution 7 – K-Map

What is the Boolean algebra equation for the following truth table?

A	B	C	O
F	F	F	T
F	F	T	F
F	T	F	T
F	T	T	T
T	F	F	F
T	F	T	F
T	T	F	T
T	T	T	T

First, draw the K-map.

	AB			
C	00	01	11	10
0	1	1	1	0
1	0	1	1	0

Next, conduct the groupings. Use the SOP method to determine the Boolean function.

$$Grouping\ of\ 000 \rightarrow \overline{ABC};\ \ Grouping\ of\ 010\ \&\ 011 \rightarrow \bar{A}B;$$

$$Grouping\ of\ 110\ \&\ 111 \rightarrow AB$$

Sum up the products.

$$\overline{ABC} + \bar{A}B + AB \rightarrow \overline{ABC} + B(\bar{A} + A) \rightarrow$$

$$\overline{ABC} + B$$

The correct answer is most nearly, (a) $\overline{ABC} + B$

(a) $\overline{ABC} + B$

7.0 Practice Exam Solutions

7.1 Practice Exam Solution 1 - Cache

A primary memory system consists of 128 address bits. Each block within the cache is 256 bytes. The total cache size is 131,072 bytes. What are the sizes of the tag and index in the cache?

First, find the number of blocks.

$$\# \, Blocks = \frac{131{,}072 \, bytes}{256 \, bytes \, per \, block} = 512 \, blocks$$

Now find the number of bits required to distinguish all the blocks. This is the index aka set size.

$$Index/Set \rightarrow 2^s = 512 \, blocks \rightarrow s = 9 \, bits$$

Next, determine the offset through the use of the block size.

$$Offset \rightarrow 2^b = 256 \, bytes \rightarrow b = 8 \, bits$$

Finally, you know that you have 128 address bits, meaning that an address must be 128 bits long. Nine of those digits will be used by the set and 8 digits will be used by the offset. The remaining will be used for the tag.

$$Total \, Address \, Bits = Tag + Index + Offset$$

$$128 \, Bits = Tag + 9 \, bits + 8 \, bits$$

$$Tag = 111 \, bits$$

The correct answer is most nearly, (b) Tag: 111 bits; Index: 9 bits.

(a) Tag: 9 bits; Index: 111 bits;

(b) Tag: 111 bits; Index: 9 bits;

(c) Tag: 9 bits; Index: 8 bits;

(d) Tag: 8 bits; Index: 128 bits;

7.2 Practice Exam Solution 2 – Cache

In a 4-set associative cache system, each block is 2 bytes and there are 128 sets. What is the total cache size and the index number of digits?

8.0 PRACTICE EXAM SOLUTIONS

8.1 PRACTICE EXAM SOLUTION 1 – ALGORITHMS

What is the Big O representation for binary search?

The correct answer is most nearly, (d) O(logn).

(a) O(n)

(b) O(nlogn)

(c) O(n^2)

(d) O(logn)

8.2 PRACTICE EXAM SOLUTION 2 - ALGORITHMS

Which of the following sort algorithms has the best Big O efficiency?

The correct answer is most nearly, (c) Merge sort.

(a) Bubble sort

(b) Insertion sort

(c) Merge sort

(d) Quick sort

8.3 PRACTICE EXAM SOLUTION 3 – TREE TRAVERSAL

The following tree is traversed post-order. Which of the following is the correct output of the post-order traversal?

1.7 PROBLEM 7 – MATHEMATICS

Find the partial derivative of the following function.

$$f(x, y) = 4\sin(3x - 7y)$$

$$\frac{\partial^2 f}{\partial x^2} = ?$$

(a) $4\cos(3x - 7y)$

(b) $-12\cos(3x - 7y)$

(c) $12\sin(3x - 7y)$

(d) $-36\sin(3x - 7y)$

1.8 PROBLEM 8 - MATHEMATICS

Find the equation of the plane that is parallel to the below plane and travels through the point (-2, 2, 2).

$$10 = 10i - 2j + 2k$$

(a) 5i + 2j + 2k = 10

(b) 10i -2j + 2k = 20

(c) 5i + j + k = 5

(d) -5i + j – k = 20

1.11 Problem 11 – Mathematics

Given the following function, solve for the following point.

$$f(x, y) = -5x^2 + y^2 - 7xy$$

$$f_y(1,1) = ?$$

(a) -10

(b) -3

(c) 7

(d) 10

1.12 Problem 12 - Mathematics

Find the derivative of the following function.

$$y = 4^{2x}$$

(a) $0.6 * 4^x$

(b) $1.3 * 4^x$

(c) $2.8 * 4^x$

(d) $2.8 * 4^{2x}$

1.13 Problem 13 – Probability & Statistics

A manufacturing process is shown to produce satisfactory products at an 80% satisfactory rate. What is the probability that only 7 out of 10 products will be satisfactory?

(a) 12%

(b) 20%

(c) 32%

(d) 70%

1.14 Problem 14 - Probability & Statistics

A population has a mean of 25 and a standard deviation of 5. The population is assumed to follow a normal distribution. What is the probability that a sample will be greater than 34?

(a) 3.6%

(b) 8.1%

(c) 13.2%

(d) 96%

1.15 Problem 15 - Probability & Statistics

What is the t-value for the following scenario? A sample group of 10 widgets is selected. The sample group has a mean of 110 and a standard deviation of 8. The population mean is estimated as 100.

(a) 1

(b) 3

(c) 4

(d) 14

1.34 Problem 34 - Engineering Sciences

An inductor has an inductance of 12 mH. It currently has 100 turns, but the amount of turns is increased to 225 turns. What is the new inductance? Assume all other variables remain the same.

(a) 18 mH

(b) 23 mH

(c) 33 mH

(d) 61 mH

1.35 Problem 35 - Engineering Sciences

An inductor with 200 turns is subject to a voltage of 0.005 V. The current changes from 0 to 5 amps in 2 seconds. At steady state the current is at 10 A. What is the magnetic flux through one turn of the coil?

(a) 0.0001 W

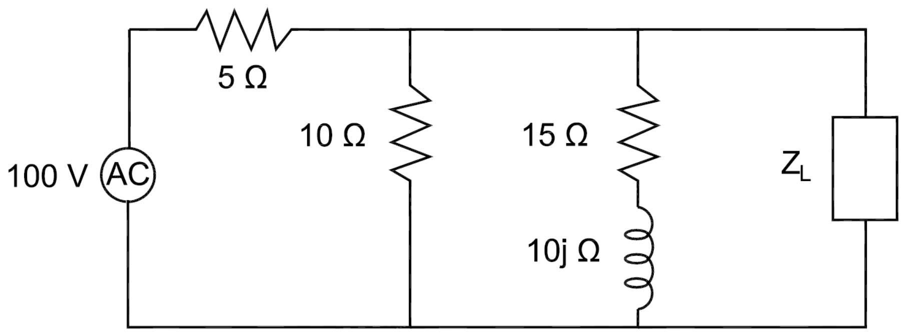
(b) 0.0005 W

(c) 0.0055 W

(d) 0.0100 W

1.42 Problem 42– Circuit Analysis

What is the Thevenin impedance at the load impedance?



(a) 3 ohms

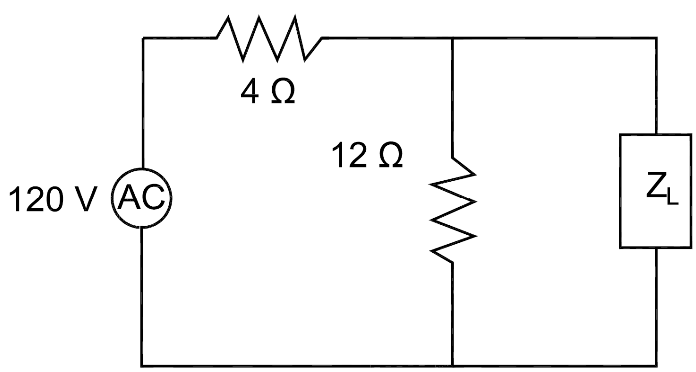
(b) 9 ohms

(c) 18 ohms

(d) 21 ohms

1.43 Problem 43– Circuit Analysis

What is the Thevenin current at the load impedance?



(a) 10 A

(b) 20 A

(c) 30 A

(d) 40 A

1.48 PROBLEM 48 - LINEAR SYSTEMS

Find the Laplace transform of the following function.

$$h(t) = 5t + 75\cos(12t)$$

(a) 5/s + 75(s/(s^2+12))

(b) 5/(s+1) + 75(s/(s^2+12))

(c) 5/s^2 + 75(s/(s^2+144))

(d) 5/(+1) + 75(s/(s^2+144))

1.49 PROBLEM 49 - LINEAR SYSTEMS

Find the inverse Laplace transform of the following function.

$$G(s) = \frac{-5}{s^2 + 8s + 41}$$

(a) $-e^{-4t}\sin(5t)$

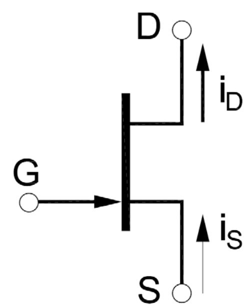
(b) $e^{4t}\sin(25t)$

(c) $e^{4t}\cos(5t)$

(d) $e^{4t}\sin(5t)$

1.66 PROBLEM 66 – ELECTRONICS

In this JFET, V_{SD} = 5 V and V_{GS} = 2 V. What is the maximum pinch off voltage? Assume the V_{SD} voltage is at saturation.



(a) 2 V

(b) 3 V

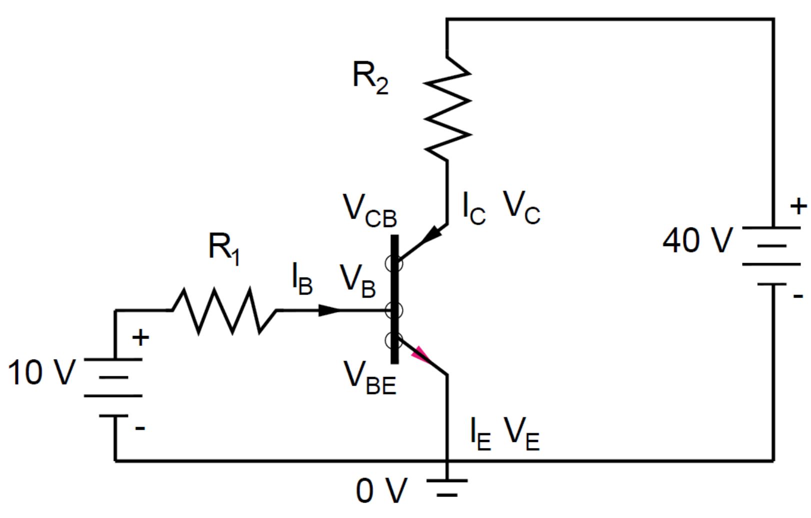
(c) 5 V

(d) 7 V

1.67 PROBLEM 67 – ELECTRONICS

What is the collector current (I_C) in the figure below?

$$R_1 = 55\ k\Omega\ ;\ \ R_2 = 22\ \Omega;\ V_{BE} = 0.7\ V;\ \alpha = 0.990$$



(a) 0.0167 A

(b) 0.0432 A

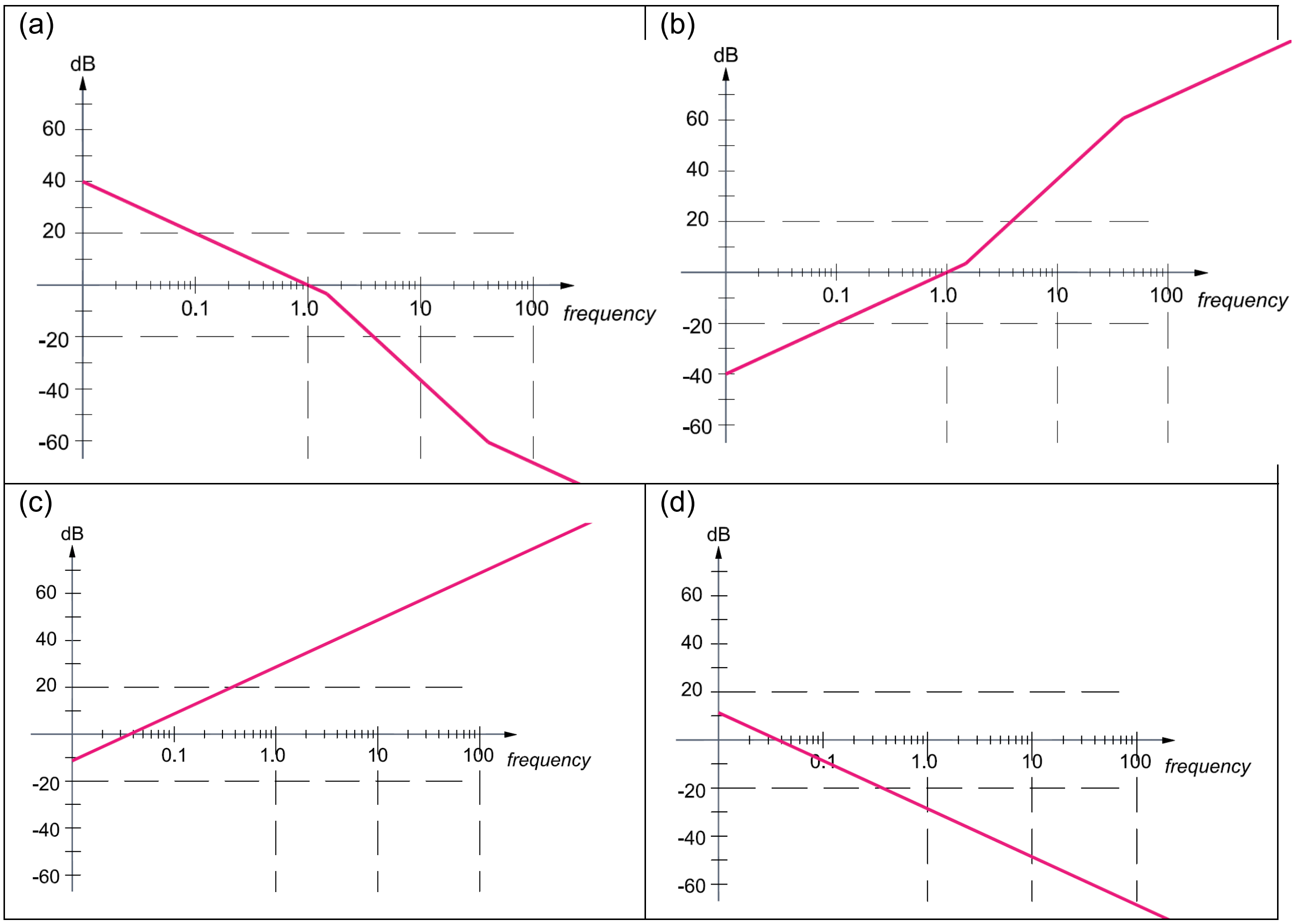
(c) 0.0981 A

(d) 0.1023 A

1.82 Problem 82 – Control Systems

Which of the following bode magnitude plots (voltage) best describes the below transfer function?

$$G(s) = -\frac{s+100}{s^2+1.2s}$$



1.101 PROBLEM 101– DIGITAL SYSTEMS

On a standard Karnaugh map, what cells have a value of “1”, given the SOP shown below?

$$A\bar{B}CD + A\overline{BC} + \overline{ACD}$$

(a) M {0, 4, 8, 9, 11}

(b) M {1, 8, 9, 10}

(c) M {0, 8, 9, 11}

(d) M {0, 1, 4, 5, 11}

1.102 PROBLEM 102– DIGITAL SYSTEMS

Find the simplified Boolean expression for the following K-map, M {0, 1, 4, 5, 11, 12, 16}

$(a)\ \overline{AC} + AD + AB\overline{CD} + ACD + ABCD$

$(b)\ \overline{ABCD} + A\overline{BC}D + \bar{A}BC\bar{D} + AB\overline{CD} + ACD$

$(c)\ \overline{AC} + AB\overline{CD} + ACD$

$(d)\ \overline{AB} + AB\overline{CD} + CD$

For this problem, use the t-value equation. The t-value is used to calculate the confidence of an estimated population mean through the use of a sample group.

$$t - value = \frac{\bar{x} - \mu}{s/\sqrt{n}}$$

$$t - value = \frac{110 - 100}{\frac{8}{\sqrt{10}}} = 3.95$$

The correct answer is most nearly, **(c) 4**.

2.16 SOLUTION 16 - PROBABILITY & STATISTICS

A fair 6-sided die is rolled 9 times. What is the probability that a 4 is rolled only once?

This problem uses the binomial distribution. The two outcomes are 4 or not 4.

$$Success(roll\ a\ 4) = p = \frac{1}{6}; Fail\ (not\ 4) = q = \frac{5}{6}$$

Use the binomial distribution to find the probability of 1(x) success out of 9 (n) trials.

$$p_n(x) = \frac{n!}{x!\,(n-x)!} p^x q^{n-x}$$

$$p_9(1) = \frac{9!}{1!\,(8)!} \frac{1}{6}^1 \frac{5}{6}^8$$

$$p_9(1) = \frac{9!}{1!\,(8)!} \frac{1}{6}^1 \frac{5}{6}^8 = 0.349$$

The correct answer is most nearly, **(b) 0.35**.

(a) 0.15

(b) 0.35

(c) 0.66

(d) 0.81

(d) The capacitance of the capacitor is indirectly related to the difference between the inner and outer radiuses.

The generic capacitance equation is the charge divided by the voltage between the two sides (positive & negative). For a cylindrical or parallel plate capacitor, you must integrate the voltage through the capacitor medium. Use the line charge electric field equation to solve for voltage.

$$C = \frac{Q}{V}$$

$$V = \int_{r_{in}}^{r_{out}} \frac{\rho_{line\ charge\ density}}{2\pi\varepsilon_0 r} dr$$

$$V = \frac{Q}{2\pi\varepsilon_0} \int_{r_{in}}^{r_{out}} \frac{1}{r} dr$$

$$V = \frac{Q}{2\pi\varepsilon_0} * [(\ln(r_{out}) - \ln(r_{in}))] = \frac{Q}{2\pi\varepsilon_0} \ln(\frac{r_{out}}{r_{in}})$$

Next, plug in the voltage into the capacitance equation.

$$C = \frac{Q}{\frac{Q}{2\pi\varepsilon_0} \ln(\frac{r_{out}}{r_{in}})} = \frac{4\pi\varepsilon_0}{\ln(\frac{r_{out}}{r_{in}})}$$

As you can see the capacitance is indirectly related to the natural log of the ratio of the outer and inner radiuses.

The correct answer is (b) the capacitance of the capacitor is indirectly related to the natural log of the ratio of the outer and inner radiuses.

2.34 SOLUTION 34 - ENGINEERING SCIENCES

An inductor has an inductance of 12 mH. It currently has 100 turns, but the amount of turns is increased to 225 turns. What is the new inductance? Assume all other variables remain the same.

(a) 18 mH

(b) 23 mH

(c) 33 mH

(d) 61 mH

The equation for inductance is shown below. You can see that the inductance is directly related to the square of the number of turns. Assume all other variables remain the same.

$$L = N^2 \mu \frac{A}{l}$$

$$\frac{12\ mH}{100^2} = \frac{L_{new}}{225^2}$$

$$L_{new} = 61\ mH$$

The correct answer is most nearly, (d) 61 mH

2.35 Solution 35 - Engineering Sciences

An inductor with 200 turns is subject to a voltage of 0.005 V. The current changes from 0 to 5 amps in 2 seconds. At steady state the current is at 10 A. What is the magnetic flux through one turn of the coil?

(a) 0.0001 W

(b) 0.0005 W

(c) 0.0055 W

(d) 0.0100 W

First, you need to find the inductance. The voltage will be equal to the rate of change in current multiplied by the inductance.

$$V = L * \frac{dI}{dt}$$

$$0.005\ V = L * \frac{5\ A}{2\ s}$$

$$L = 0.002\ H$$

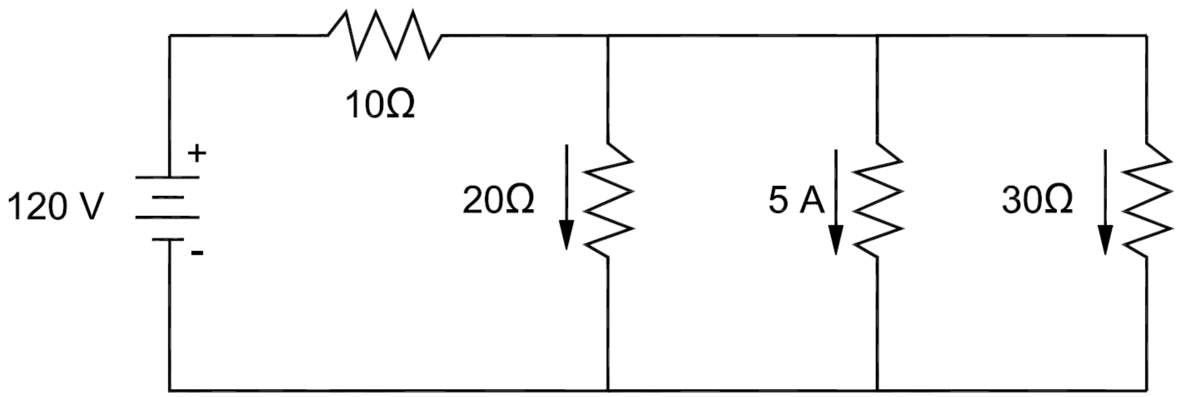
Next, use the magnetic flux equation.

$$\Phi = \frac{L * I}{N} = \frac{0.002\ H * 10\ A}{200\ turns} = 0.0001\ webers$$

The correct answer is most nearly, (a) 0.0001 W.

2.37 Solution 37 – Circuit Analysis

What is the current through the 10 ohm resistor?



First, create a KVL around 120 V, 10 ohm resistor and the voltage across the remaining resistors in parallel. Call this voltage V_2.

$$KVL \rightarrow 120V = I_{10} * 10 + V_2$$

$$I_{10} = \frac{120 - V_2}{10}$$

Next, create a KCL node at the intersection of the 20 ohm and 10 ohm resistor. The current into the node is equal to I_{10} (current through 10 ohm resistor). The current out of the node is equal to the current through the remaining resistors.

$$KCL \rightarrow I_{10} = \frac{V_2}{20} + 5 + \frac{V_2}{30}$$

You have two equations and two unknowns. Solve for V_2 first.

$$\frac{120 - V_2}{10} = \frac{V_2}{20} + 5 + \frac{V_2}{30}$$

$$120 - V_2 = 0.5V_2 + 50 + \frac{1}{3}V_2$$

$$70 = 1.833V_2$$

$$V_2 = 38.2\ V$$

Now solve for I10, the current through the 10 ohm resistor.

$$I_{10} = \frac{120 - V_2}{10} = \frac{120 - 38.2\ V}{10} = 8.2\ A$$

(a) 4.1 A

(b) 5.5 A

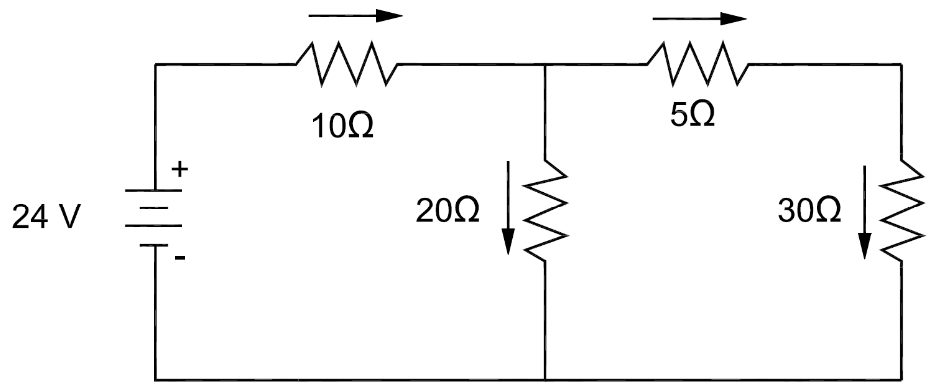
(c) 8.2 A

(d) 10.9 A

The correct answer is most nearly, (c) 8.2 A.

2.38 Solution 38 – Circuit Analysis

What is the current through the 20 ohm resistor?



The 5 ohm and 30 ohm resistors are in series, so those can be combined to 35 ohms. Then the 35 ohm and 20 ohm resistors can be combined in parallel to 12.7 ohms. Finally, the 10 ohm resistor can be combined in series for 22.7 ohms.

$$Ohms\ Law \rightarrow 24\ V = \left(10 + \left[\frac{1}{20} + \frac{1}{30+5}\right]^{-1}\right) I$$

$$I = \frac{24\ V}{22.7\ ohms} = 1.056\ A$$

Now find the current through the 20 ohm resistor with KCL.

$$1.056\ A = I_{20} + I_{35}$$

But you know through the current divider rule that the current through the 35 ohm resistor is less than the 20 ohm resistor, by the ratio 20/35.

$$1.056\ A = I_{20} + \frac{20}{35} I_{20}$$

$$I_{20} = 0.67$$

The correct answer is most nearly, (a) 0.67 A.

(a) 0.67 A

(b) 0.89 A

(c) Unable to tell

(d) Less than 1

2.41 Solution 41– Circuit Analysis

An RL circuit (series) was previously operated at AC at 50 Hz. However, the frequency has been changed to 60 Hz. What will be the ratio of the old to new phase angle magnitudes?

A RL circuit will have a resistor and inductor in series. The impedances can be added.

$$Z = R + C = R + j(2\pi f)L$$

$$w = 2\pi f$$

The phase angle can be found through the following equation. But you can also visualize a right triangle with the length of the triangle on the x-axis equal to the magnitude of the resistor and the length on the y-axis equal to the magnitude of the inductor impedance.

$$\tan(phase\ angle) = \left(\frac{2\pi f L}{R}\right)$$

An increase in the frequency from 50 to 60 Hz will cause the tangent of the phase angle to increase. This will cause the phase angle to increase.

The correct answer is most nearly, (a) Greater than 1.

(a) Greater than 1

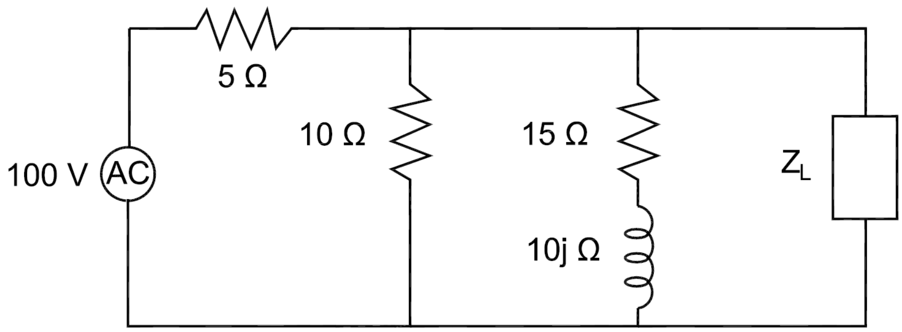
(b) 1

(c) Unable to tell

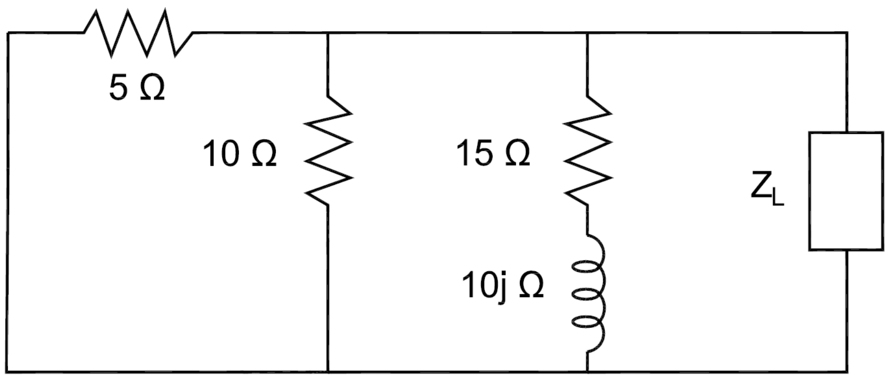
(d) Less than 1

2.42 Solution 42– Circuit Analysis

What is the Thevenin impedance at the load impedance?



In order to find the Thevenin equivalent impedance, short all voltage sources and open all current sources.



The 5 ohm and 10 ohm resistors are in parallel.

$$\frac{1}{R_{par}} = \frac{1}{5} + \frac{1}{10} \rightarrow \; R_{par} = 3.33 \; ohms$$

Now, combine the previous resistance in parallel with the 15 +10j resistance.

$$\frac{1}{Z_{TH}} = \frac{1}{3.33} \; ohms + \frac{1}{15 \; + 10 \; j} ohms$$

$$Z_{TH} = 2.9\angle 5°$$

The magnitude is just 2.9.

The correct answer is most nearly, (a) 3 ohms.

(a) 3 ohms

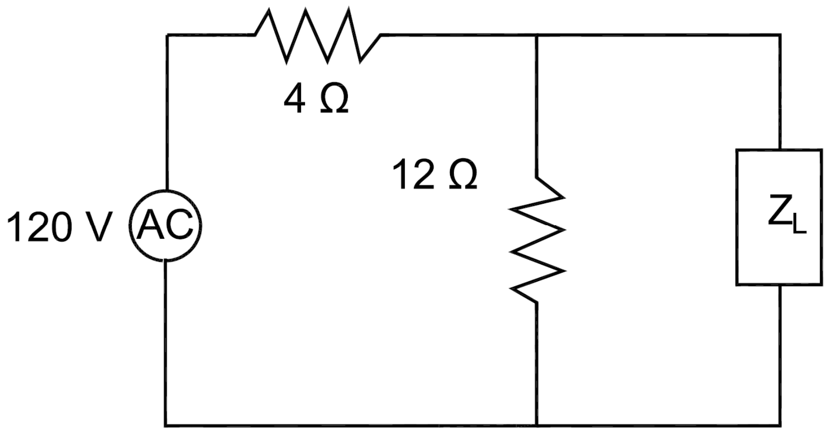
(b) 9 ohms

(c) 18 ohms

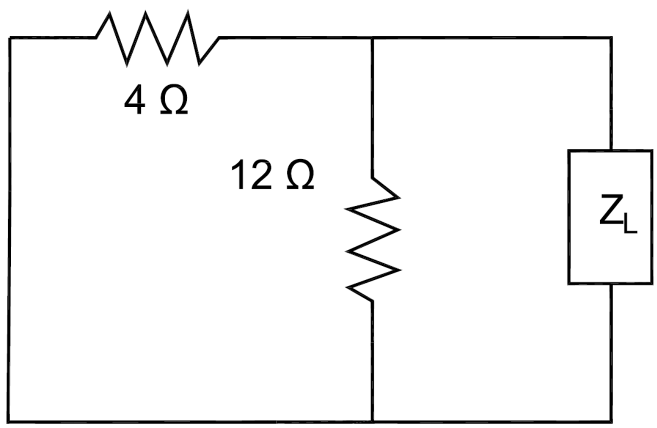
(d) 21 ohms

2.43 SOLUTION 43– CIRCUIT ANALYSIS

What is the Thevenin current at the load impedance?



First, short the voltage sources and open the current sources. Then find the equivalent impedance.



The Thevenin impedance is as shown below.

$$Z_{th} = \left(\frac{1}{4} + \frac{1}{12}\right)^{-1} = 3\ ohms$$

Next, find the current by dividing the voltage by the impedance.

$$I_{norton} = \frac{120\ Volts}{3\ ohms} = 40\ A$$

The correct answer is most nearly, (d) 40 A.

(a) 10 A

(b) 20 A

(c) 30 A

$$5\frac{1}{s^2} + 75\frac{s}{s^2 + 12^2}$$

The correct answer is most nearly, (c) 5/s^2 + 75(s/(s^2+144))

(a) 5/s + 75(s/(s^2+12))

(b) 5/(s+1) + 75(s/(s^2+12))

(c) 5/s^2 + 75(s/(s^2+144))

(d) 5/(+1) + 75(s/(s^2+144))

2.49 Solution 49 - Linear Systems

Find the inverse Laplace transform of the following function.

$$G(s) = \frac{-5}{s^2 + 8s + 41}$$

The closest inverse Laplace transform for the above function is shown below.

$$g(t) = e^{-at}\sin(Bt) \rightarrow G(s) = \frac{B}{(s+a)^2 + B^2}$$

So, you need to put the previous function somehow into this above format. First, you can assign B as 5 and move the negative to the outside of the function.

$$G(s) = -\frac{5}{(s+a)^2 + 25}$$

Subtract 25 from 41 and the remaining has to go into the (s+a) term.

$$G(s) = -\frac{5}{s^2 + 8s + 16 + 5^2}$$

$$G(s) = -\frac{5}{(s+4)^2 + 5^2}$$

Now, a = 4 and B = 5. Take the inverse Laplace transform and remember to include the negative sign.

$$g(t) = e^{-at}\sin(Bt) = -e^{-4t}\sin(5t)$$

The correct answer is most nearly, (a) –e^{-4t}sin(5t)

(a) –e^{-4t}sin(5t)

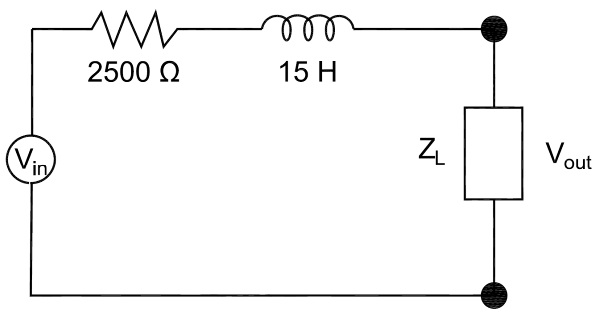
(b) e^{4t}sin(25t)

(c) e^{4t}cos(5t)

(d) $e^{4t}\sin(5t)$

2.50 SOLUTION 50 - LINEAR SYSTEMS

Find the transfer function of the below circuit. ZL is a capacitor (0.3 uF).



$$H(s) = \frac{V_{out}(s)}{V_{in}(s)}$$

First, find the equivalent resistance of all the components. Since all the components are in series, you can convert to impedance and then add up all the impedances.

$$Z_{eq} = 2500\ \Omega + jw(15)\ \Omega + \frac{1}{\mathrm{jw}(0.3 \times 10^{-6})}$$

$$Z_{eq} = 2500\ \Omega + jw(15)\ \Omega + \frac{1}{\mathrm{jw}(0.3 \times 10^{-6})}$$

All of the jw components become "s" components.

$$Z_{eq} = 2500 + 15s + \frac{3{,}333{,}333}{s}$$

Create a common denominator so all components can be added.

$$Z_{eq} = \frac{2500s}{s} + \frac{15s^2}{s} + \frac{3{,}333{,}333}{s}$$

$$Z_{eq} = \frac{15s^2 + 2500s + 3{,}333{,}3333}{s}$$

Now solve for the current through the circuit.

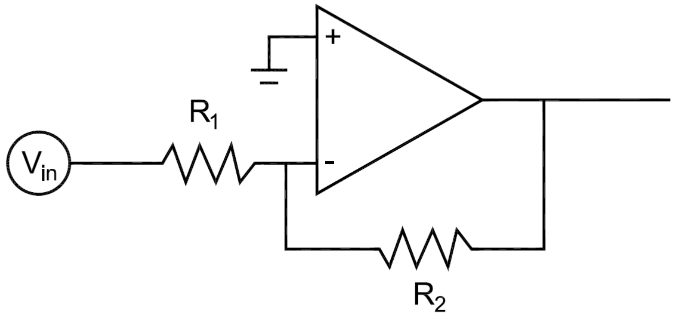
$$V_{in} = IZ_{eq}$$

$$I = V_{in}\frac{s}{15s^2 + 2500s + 3{,}333{,}3333}$$

Finally, solve for H(s).

Which of the following is true about the below amplifier?

$$R_1 = 5\ \Omega\,;\ \ R_2 = 23\ \Omega;$$



Since the positive side is to ground, this means you have an inverting amplifier. Please find the amplifier section within the *NCEES FE Reference Handbook*.

$$Gain = \frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1} = -\frac{23}{5} = -4.6$$

The correct answer is most nearly, (a) This is an inverting amplifier with a gain of 4.6.

(a) This is an inverting amplifier with a gain of 4.6.

(b) This is a non-inverting amplifier with a gain of 4.6.

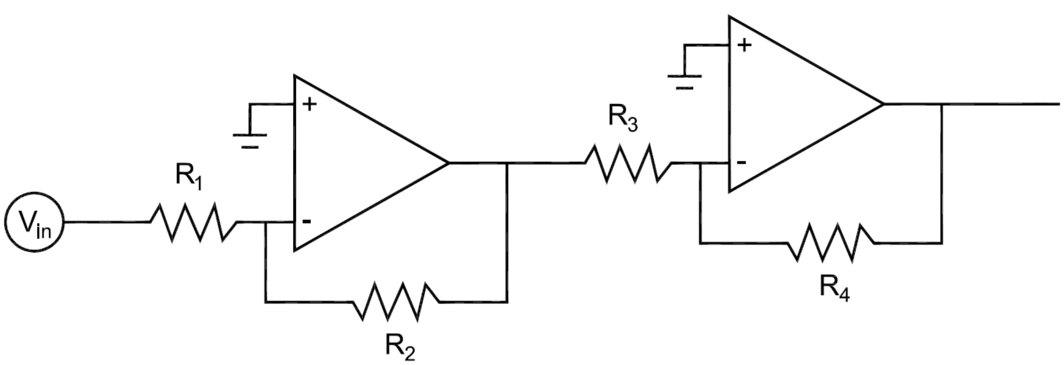
(c) This is an inverting amplifier with a gain of -4.6.

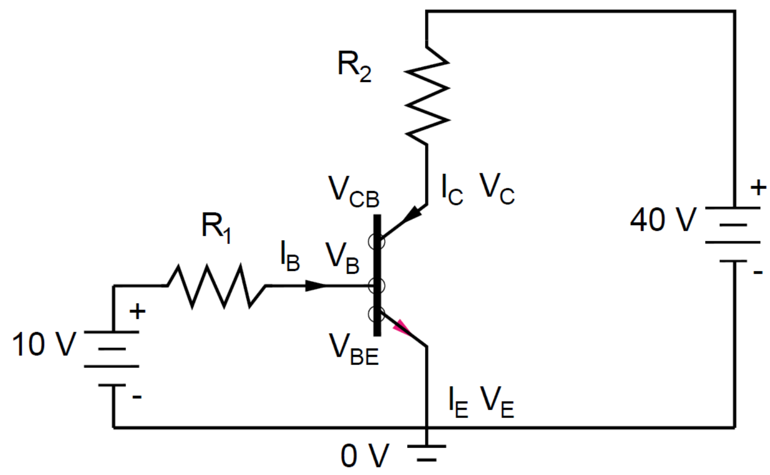
(d) This is a non-inverting amplifier with a gain of 0.22.

2.63 SOLUTION 63 – ELECTRONICS

What value of R_3 will provide a gain of 2?

$$R_1 = 5\ \Omega\,;\ \ R_2 = 18\ \Omega;\ \ R_3 = ??\ \Omega;\ \ R_4 = 15\ \Omega;$$





First, use the alpha equation to find beta.

$$\alpha = \frac{\beta}{\beta + 1} \rightarrow (\beta\alpha + \alpha) = \beta \rightarrow \alpha = \beta - \beta\alpha$$

$$\alpha = \beta(1 - \alpha)$$

$$\beta = \frac{\alpha}{1 - \alpha} = \frac{0.990}{1 - 0.990} = 99$$

Next, use KVL around the 10 V loop with the base current as a function of the collector current.

$$10\ V = \frac{1}{\beta} I_C * R_1 + V_{BE}$$

$$10\ V = \frac{1}{99} I_C * 55{,}000\ \Omega\ + 0.7\ V$$

$$I_C = 0.0167\ A$$

The correct answer is most nearly, **(a) 0.0167 A**

(a) 0.0167 A

(b) 0.0432 A

(c) 0.0981 A

(d) 0.1023 A

According to the NCEES FE Reference Handbook, the equation for electric flux density is as shown below.

$$D = \varepsilon E$$

$$D = electric\ flux\ density \left(\frac{C}{m^2}\right);\ \varepsilon = permittivity\ of\ air \left(8.85\ x\ 10^{-12}\frac{F}{m}\right);$$

$$E = electric\ field\ intensity \left(\frac{V}{m}\right)$$

Another way to represent Farads is with C/V coulombs per volt.

$$2.00\ x\ 10^{-11}\ C/m^2 = \left(8.85\ x\ 10^{-12}\frac{C}{m-V}\right)E$$

$$E = 2.26\ V/m$$

The correct answer is most nearly, (a) 2.3 V/m.

(a) 2.3 V/m

(b) 13.1 V/m

(c) 37.6 V/m

(d) 102 V/m

2.82 Solution 82 – Control Systems

Which of the following best describes the Bode plot of the following transfer function? Assume voltage as the magnitude.

$$G(s) = -\frac{s+100}{s^2+1.2s}$$

First, format the transfer function.

$$G(s) = -\frac{s+100}{s(s+1.2)}$$

Next, determine the poles, zeros and constants.

$$Constant = 1$$

The zeros occur when the numerator is equal to zero. Since this is a first order polynomial, there should be only one zero.

$$Zeros \rightarrow s = -100$$

$$Non\ Zero\ Zeros \rightarrow db = 20\log|-100| = 40$$

Next, find each cell.

$$A\bar{B}CD = 1011;\ A\overline{BC} = 1000\ \&\ 1001;\ \overline{ACD} = 0100\ \&\ 0000$$

$$1011 = 11;\ 1000 = 8;\ 1001 = 9;\ 0100\ = 4;\ 0000 = 0;$$

The correct answer is most nearly, (a) M {0, 4, 8, 9, 11}.

(a) M {0, 4, 8, 9, 11}

(b) M {1, 8, 9, 10}

(c) M {0, 8, 9, 11}

(d) M {0, 1, 4, 5, 11}

2.102 SOLUTION 102 – DIGITAL SYSTEMS

Find the simplified Boolean expression for the following K-map, M {0, 1, 4, 5, 11, 12, 15}

First, complete the K-map.

	AB			
CD	00	01	11	10
00	1	1	1	0
01	1	1	0	0
11	0	0	1	1
10	0	0	0	0

Next, make groupings of 1, 2, 4, 8 or 16.

	AB			
CD	00	01	11	10
00	1	1	1	0
01	1	1	0	0
11	0	0	1	1
10	0	0	0	0

Now, write the sum of products equations.

$$Left\ Grouping = \overline{AC};\ Right\ Top\ Grouping = AB\overline{CD};\ Right\ Bottom\ grouping = ACD;$$

Finally, simplify the equation.