EE301 Fall 2009
COURSE OBJECTIVES

LESSON 1 – COURSE INTRODUCTION & UNITS

A. Describe EE301 Course Policy.
B. Review and interpret the Course Syllabus.
C. Apply SI units and engineering notation for standard electrical quantities.
D. Apply unit conversion factors when solving engineering problems
E. Convert a pictorial diagram to a schematic diagram.

LESSON 2 – CURRENT & VOLTAGE

A. Differentiate between free electron and an ion.
B. Differentiate between a conductor, insulator and semiconductor assess when each would be used in an electrical circuit.
C. Describe the concept of voltage potential.
D. Describe the flow of electrons and evaluate how this relates to current.
E. Describe the relationship between battery capacity, current drain and battery's useful life.
F. Describe the effect of connecting DC voltage sources (e.g. battery) in series and in parallel.
G. Demonstrate the position of a meter for measuring current and voltage.
H. Describe the basic function of a fuse or a switch.

LESSON 3 – RESISTANCE AND OHM'S LAW

A. Identify the factors that limit the flow of electrons and apply this to calculating resistance.
B. Examine how resistors are used to control voltage and current and predict when fixed or variable resistors would be used in an electrical circuit.
C. Given a color code table, determine the value and tolerance of fixed resistors using their color codes.
D. Demonstrate how to measure resistance in a circuit.
E. State Ohm's law in its various forms and use Ohm's law to calculate current, voltage, and resistance values in a circuit.
F. Explain how current, voltage and resistance are related in a circuit. Draw a schematic of a typical electrical circuit, and explain the purpose of each component and indicate the polarity and current direction.
G. Discuss the difference between an open circuit and a short circuit.

LESSON 4 – POWER & ENERGY

A. Define and explain the relationship between power and energy and relate this relationship to voltage and current.
B. Calculate power supplied/dissipated in a circuit.
C. Properly select resistors based on power considerations.
D. Calculate the power efficiency of a circuit.
E. Calculate the total cost given a rate of energy consumption.

LESSON 5 – SERIES CIRCUITS & KVL

A. Explain the definition of a series circuit.
B. Identify elements that are connected in series.
C. Construct series circuits and demonstrate how to measure resistance, current and voltage.
D. State and apply KVL in analysis of a series circuit.
E. Determine the net effect of series-aiding and series-opposing voltage sources.

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LESSON 6 – VOLTAGE DIVIDER & REFERENCE VOLTAGE

A. Explain and compute how voltage divides between elements in a series circuit.
B. Compute voltage drops across resistors using the voltage divider formula.
C. Compute the power dissipated by each element and the total power in a series circuit.
D. Apply concept of voltage potential between two points to the use of subscripts and the location of the reference voltage.
E. Analyze a series resistive circuit with the ground placed at various points

LESSON 7 – PARALLEL CIRCUITS AND KCL

A. Restate the definition of a node and demonstrate how to measure voltage and current in parallel circuits.
B. Solve for total circuit resistance of a parallel circuit.
C. State and apply KCL in the analysis of simple parallel circuits.
D. Demonstrate how to calculate the total parallel resistance given various resistors connected in parallel.
E. Demonstrate how to calculate the total parallel resistance given n resistors of equal value in parallel.

LESSON 8 – PARALLEL VOLTAGE SOURCES AND CURRENT DIVIDER RULE.

A. Demonstrate how to calculate the total current and branch currents in a parallel circuit using the current divider equation.
B. Determine the net effect of parallel combining voltage sources.
C. Compute the power dissipated by each element in a parallel circuit, and calculate the total circuit power.
D. Evaluate why homes, businesses and ships are commonly wired in parallel rather than series.

LESSON 9 - SERIES-PARALLEL CIRCUITS

A. Apply the rules for analyzing series and parallel circuits to a series-parallel circuit.
B. Compute the total resistance in a series-parallel circuit.
C. Analyze series-parallel circuits for current through and voltage across each component.
D. Analyze the power dissipated by each element in a series parallel circuit and calculate the total circuit power.

LESSONS 10 – CURRENT SOURCES AND SOURCE CONVERSIONS

A. Analyze a circuit consisting of a current source, voltage source and resistors.
B. Convert a current source and a resister into an equivalent circuit consisting of a voltage source and a resistor.
C. Evaluate a circuit that contains several current sources in parallel.

LESSON 11 – NODAL ANALYSIS PART I

A. Apply Ohm’s Law using nodal voltages.
B. Apply the Nodal Analysis method to determine an unknown node voltage and branch currents in a simple DC circuit.

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LESSON 12 – NODAL ANALYSIS PART II

A. Apply Nodal Analysis to circuits with current sources.
B. Apply Nodal Analysis to solve equations with multiple unknown nodal voltages.
C. Use the TI calculator SOLVE function to solve for multiple unknown voltages in a complex DC circuit.

LESSON 13 – THÈVENIN'S THEOREM I

A. State and explain Thèvenin's theorem.
B. List the procedure for determining the Thèvenin equivalence of an actual circuit from the standpoint of two terminals.
C. Apply Thèvenin's Theorem to simplify a circuit for analysis.

LESSON 14 – THÈVENIN'S THEOREM II AND MAX POWER TRANSFER

A. Analyze complex series-parallel circuits using Thèvenin's theorem.
B. Apply the Maximum Power Transfer theorem to solve appropriate problems.

LESSON 15 - LINEAR MOTORS

A. Explain the difference between permanent magnets and electromagnets.
B. Identify lines of magnetic flux in a permanent magnet, straight line current carrying conductor, and current-carrying coil.
C. Define flux density, magnetic field intensity, and magnetic flux.
D. Understand the direction of force on a current-carrying conductor in a magnetic field (Lorentz Force Law).
E. Analyze the Lorentz Force Law in a DC linear motor.
F. Understand the effect of a changing magnetic field upon a current-carrying closed path conductor (Faraday/Lenz/Electromotive Force).

LESSON 16 – DC MOTORS I

A. Identify and define the components of a two pole permanent magnetic DC motor (stator, armature, commutator and brushes).
B. Given the direction of a magnetic field in a two pole permanent magnetic DC motor, determine the direction of force applied to a single armature loop (Lorentz Force Law).
C. Understand the effect of multiple armature loops in a DC motor.
D. Understand the induced effects of rotating a current-carrying closed loop conductor in a magnetic field (Faraday/Lenz/Electromotive Force)

LESSON 17 – DC MOTORS II

A. Define induced electromotive force (back EMF) in terms of flux, angular velocity and a given DC motor constant.
B. Define developed electromagnetic torque on a DC motor in terms of flux, armature current, and a given DC motor constant.
C. Analyze the circuit equivalent of a permanent magnetic DC motor that accounts for armature resistance, induced electromotive force (back EMF), developed electromagnetic torque, and applied (input) voltage.
D. Define the power output of a permanent magnetic DC motor in terms of developed electromagnetic torque and angular velocity. Relate power output in terms of horse power.

E. Determine the efficiency of a permanent magnetic DC motor using the given or calculated power in and power out.

LESSON 18 – CAPACITORS

A. Define capacitance and state its symbol and unit of measurement.
B. Analyze how a capacitor stores charge and energy and relate this understanding to dielectric, effect of spacing and electric fields.
C. Predict capacitance based on capacitor dielectric.
D. Explain breakdown voltage.
E. Calculate capacitor voltage and current as a function of time.
F. Explain capacitor DC characteristics.
G. Calculate capacitor energy storage.

LESSON 19 – INDUCTORS

A. State Faraday's Law
B. Define inductance and state its symbol and unit of measurement.
C. Define counter EMF.
D. Predict the inductance of a coil of wire.
E. Calculate inductor voltage and current as a function of time.
F. Explain inductor DC characteristics.
G. Calculate inductor energy stored.

LESSON 20 – SINUSOIDS

A. Contrast AC voltage sources and DC voltage sources as defined by voltage polarity and magnitude over time.
B. Contrast AC currents and DC currents as defined by current direction and magnitude over time.
C. Describe the operation of a simple AC generator.
D. Define peak value and peak to peak values for a waveform.
E. Scale a sinusoidal cycle in degrees or time.
F. Define the basic sinusoidal wave equations and waveforms, and determine amplitude, phase, period, frequency, and angular velocity.
H. Determine the instantaneous value of a sinusoidal waveform.
I. Graph basic sinusoidal wave equations as a function of time and angular velocity using degrees and radians.
J. Using an oscilloscope, measure peak voltage, peak to peak voltage, and period of a sinusoidal wave.

LESSON 21 – PHASORS

A. Define phase shift. Graph and compute phase difference between voltage and current waveforms.
B. Define a phasor.
C. Use phasors to represent sinusoidal voltages and currents.
D. Determine phase differences between same frequency waveforms.
E. Determine when a sinusoidal waveform leads or lags another. Graph a phasor diagram that illustrates phase relationships.

F. Interpret the meaning of "average value" for AC waveforms.
G. Define effective / root mean squared values.
H. Develop an average power equation for the real power dissipated in a resistor by AC current.
I. Using a multimeter and an oscilloscope determine RMS values of AC voltages and current.

LESSON 22 – COMPLEX NUMBERS IN AC ANALYSIS

A. Define and graph complex numbers in rectangular and polar form.
B. Perform addition, subtraction, multiplication and division using complex numbers and illustrate those using graphical methods.
C. Represent a sinusoidal voltage or current as a complex number in polar and rectangular form.
D. Define time domain and phasor (frequency) domain
E. Use the phasor domain to add/subtract AC voltages and currents.

LESSON 23 - IMPEDANCE

A. For purely resistive, inductive and capacitive elements define the voltage and current phase differences.
B. Define inductive reactance.
C. Understand the variation of inductive reactance as a function of frequency.
D. Define capacitive reactance.
E. Understand the variation of capacitive reactance as a function of frequency.
F. Define impedance.
G. Graph impedances of purely resistive, inductive and capacitive elements as a function of phase.

LESSON 24 - AC SERIES CIRCUITS

A. Compute the total impedance for a series AC circuit.
B. Apply Ohm's Law, Kirchhoff's Voltage Law and the voltage divider rule to AC series circuits.
C. Graph impedances, voltages and current as a function of phase.
D. Graph voltages and current as a function of time.

LESSON 25 – AC PARALLEL CIRCUITS

A. Compute the total impedance for AC parallel circuits.
B. Apply Kirchhoff's Current Law and the current divider rule to AC parallel circuits.
C. Graph impedance, voltages and current as function of phase.
D. Graph voltages and current as a function of time.

LESSON 26 – ADVANCED AC CIRCUITS

A. Determine total impedance of AC parallel and series circuits.
B. Apply Ohm's Law, Kirchhoff's Voltage Law, voltage divider rule, Kirchhoff's Current Law, and current divider rule to AC series parallel networks and its elements.
C. Solve AC series parallel networks.
D. Using an oscilloscope to measure AC voltages across elements in AC series parallel networks and calculate AC currents.

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LESSON 27 – AC POWER
A. Define real (active) power, reactive power and average power.
B. Calculate the real and reactive power in AC series parallel networks.
C. Graph the real and reactive power of purely resistive, inductive, or capacitive loads in AC series parallel networks as a function of time.
D. Determine when power is dissipated, stored, or released in purely resistive, inductive, or capacitive loads in AC series parallel networks.
E. Calculate the total real and total reactive power consumed in AC series parallel networks.

LESSON 28 – POWER TRIANGLE
A. Define apparent power.
B. Calculate apparent power in AC series parallel networks.
C. Define the power triangle.
D. Using the power triangle, determine relationships between real, reactive and apparent power.
E. Determine if AC series parallel networks are inductive, capacitive, or purely resistive.

LESSON 29 – POWER FACTOR CORRECTION
A. Define power factor.
B. Define unity, leading and lagging power factors.
C. Define power factor correction and unity power factor correction.
D. Calculate the inductor or capacitor value required to correct AC series parallel networks to the desired apparent power.
E. Compare currents, voltages, and power in AC series parallel networks before and after power factor correction.

LESSON 30 – AC SOURCE TRANSFORMATION AND AC THÈVENIN I
A. Construct equivalent circuits by converting an AC voltage source and a resistor to an AC current source and a resistor.
B. Apply Thèvenin's Theorem to simplify an AC circuit for analysis.

LESSON 31 – AC THÈVENIN II & MAX POWER TRANSFER
A. Explain under what conditions a source transfers maximum power to a load.
B. Determine the value of load impedance for which maximum power is transferred from the circuit.

LESSON 32 – MAGNETISM & TRANSFORMERS I
A. Analyze the relationship between the transformation ratio, voltage ratio, current ratio, and impedance ratio.
B. Construct a circuit equivalent of a transformer and calculate primary and secondary voltage, current and polarity.
C. Explain the relationship between the power developed in the primary and secondary of a transformer.

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LESSON 33 – TRANSFORMERS II & REFLECTED LOADS

A. Predict the reflected impedance and derive an equivalent circuit using the reflected impedance.
B. Calculate the transformation ratio to deliver maximum power to a load.
C. Determine safe operation parameters from power transformer ratings.
D. Explain how the transformer acts as an isolation device.
E. List and explain several practical applications of transformers.

LESSONS 34 – INTRODUCTION TO AC GENERATORS

A. Review the operation of a single phase two pole AC generator.
B. Identify and define the components of a three phase two pole AC generator to include rotor, stator, armature, field windings, slip rings and brushes.
C. Understand the effects of applying a DC voltage power supply to a two pole rotor's field windings via brushes and slip rings.
D. Understand the induced effects that result from rotating the rotor's electromagnetic field past the armatures (Faraday's Law).
E. Given the armature coil sequence and their physical location, plot the induced AC voltages for a three phase two pole AC generator as a function of time and as phasors.
F. Understand the relationship between the number of poles and rpm of the rotor to the induced AC current's frequency.

LESSON 35 – THREE-PHASE SOURCES AND LOADS

A. Review the induced AC voltage output for a three phase AC generator as a function of time and as phasors.
B. Define a three-wire Y-Y three phase circuit and a four-wire Y-Y three phase circuit.
C. Define the symbols for line to neutral voltages, line to line voltages, line currents, and phase impedances that will be used in three phase circuits.
D. Plot the phasors of line to line voltages and line to neutral voltages for a Y-Y three phase circuit.
D. Analyze Ohm's law in a three-wire Y-Y three phase circuit and in a four-wire YY three phase circuit using a basic three phase generator that produces three balanced voltages which are connected to balanced loads.
E. Analyze Kirchhoff's current law in a three-wire Y-Y three phase circuit and in a four-wire Y-Y three phase circuit using a basic three phase generator that produces three balanced voltages with a Y connected balanced purely resistive loads.

LESSON 36 – CONVERSION TO PER PHASE ANALYSIS

A. Derive the relationship between line to line voltages and line to neutral voltages in a balanced Y-Y three phase circuit.
B. For a balanced Y-Y three phase circuit convert the line to line voltage phasor to the line to neutral voltage phasor and vice versa.
C. Derive the relationship between line current and phase load current in a balanced Y- Δ three phase circuit.
E. For a balanced Y- Δ three phase circuit convert the line current phasor to phase load current phasor and vice versa.
F. Plot the phasors of line current and phase load current in a balanced Y- Δ three phase circuit.

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LESSON 37 – THREE PHASE POWER AND AC GENERATORS

A. Compute the real, reactive and apparent power in three phase systems.
B. Apply power factor correction to three phase systems.
C. Calculate the real power, reactive power and apparent power for a three phase generator.
D. Apply the principles of Power Factor Correction to a three phase load.

LESSON 38 – AC GENERATORS PART II

A. Use the power conversion diagram to describe power flow for a three phase generator.
B. Find line voltages and current for a Y-connected three phase generator.

LESSON 39 – SHIPBOARD ELECTRICAL DISTRIBUTION

A. Explain the rating of a Ships Service Diesel Generator
B. Draw and explain the simplified diagram of a warship's 450-VAC/120-VAC distribution system.
C. Discuss the concept of vital and non-vital busses and the loads typically powered by each.
D. Explain the purpose of shore power and how it is paralleled with ship's power.
F. Define a bus, bus-tie breaker, split-plant operation, and parallel plant operation.