College of San Mateo
Official Course Outline

1. **COURSE ID:** ELEC 405 **TITLE:** Transformers and Rotating Machinery
   Units: 2.0 units **Hours/Semester:** 24.0-27.0 Lecture hours; and 24.0-27.0 Lab hours
   Method of Grading: Letter Grade Only
   Prerequisite: Completion of or concurrent enrollment in ELEC 112.

2. **COURSE DESIGNATION:**
   Degree Credit
   Transfer credit: CSU

3. **COURSE DESCRIPTIONS:**
   Catalog Description:
   This course deals with the electrical equipment used to produce rotary energy. Four main topics are included: three-phase power, transformers, generators, and motors. Device characteristics, operating theory, system interconnection, and basic control devices are covered. Troubleshooting and logical circuit tracing are emphasized.

4. **STUDENT LEARNING OUTCOME(S) (SLO'S):**
   Upon successful completion of this course, a student will meet the following outcomes:
   1. Describe the difference between single-phase and three-phase power.
   2. Explain how a transformer operates and state the voltage, current, power, and impedance relationships associated with transformers.
   3. Demonstrate how to phase a transformer winding.
   4. Demonstrate how to connect transformers in wye and delta configurations and be able to compute transformer voltages and currents.
   5. Explain the operation of DC and AC electromechanical generators.
   6. Explain the operation of single-phase and three-phase motors.
   7. Demonstrate how to connect single-phase and three-phase motors to a power source via a two-wire and a three-wire control circuit.

5. **SPECIFIC INSTRUCTIONAL OBJECTIVES:**
   Upon successful completion of this course, a student will be able to:
   1. Describe the difference between single-phase and three-phase power.
   2. Explain how a transformer operates and state the voltage, current, power, and impedance relationships associated with transformers.
   3. Demonstrate how to phase a transformer winding.
   4. Demonstrate how to connect transformers in wye and delta configurations and be able to compute transformer voltages and currents.
   5. Explain the operation of DC and AC electromechanical generators.
   6. Explain the operation of single-phase and three-phase motors.
   7. Demonstrate how to connect single-phase and three-phase motors to a power source via a two-wire and a three-wire control circuit.

6. **COURSE CONTENT:**
   Lecture Content:
   1. Introduction to Three-Phase Power
      A. Three-phase voltage, current, and power relationships
      B. The three-phase phasor diagram including equations
      C. Delta vs. wye configuration for source and load
      D. The concept of neutral
      E. Balanced vs. unbalanced loads
      F. The stringer wire
      G. Power in 3-phase systems
         a. Real power (W)
         b. Reactive power (VAR)
         c. Apparent power (VA)
      H. Power factor significance

2. Transformer Basics
    A. Magnetism and electromagnetism
    B. Operating principles
    C. Electrical safety
    D. Windings
        a. Tapped
        b. Single phase
        c. Three-phase
        d. Polarity
        e. Voltage, current, impedance, and turns ratio
        f. Transformer power and loss rating
        g. Transformer connections
        h. Harmonics
        i. Reactors and isolation transformers
        j. Autotransformers
        k. Buck-boost transformers
        l. Special transformers
            i. Current transformers
            ii. Instrument transformers
        m. Selection and installation
        n. Maintenance and troubleshooting
3. Power distribution systems
    A. Transmission systems
    B. Unit substations
    C. Distribution systems
    D. Switchboards and panel boards
    E. Motor control centers (MCCS)
4. DC and AC generators
    A. Magnetism, electromagnetism, and electricity generation
    B. Faraday and the basic generator principle
    C. Factors that determine generator output voltage and current
    D. Generators wars--Edison vs. Tesla
    E. Basic DC generator
        a. The development of the commutator
        b. DC generator construction
        c. DC generator output stabilization--V and I
    F. Basic AC generator
        a. The development of the slip ring
        b. Rotating field vs. rotating coil
        c. AC generator construction
        d. AC generator output stabilization--V, I, and f
5. DC and AC motors
    A. Motor principle
        a. Magnetism
        b. Electromagnetism
        c. Motor rotation
    B. Direct current motors
        a. Permanent-magnet DC motor
        b. Series DC motor
        c. Shunt DC motor
        d. Compound DC motor
        e. Direction of rotation
        f. Motor Counter Electromotive Force (CEMF)
        g. Armature reaction
        h. Speed regulation
        i. Varying DC motor speed
        j. DC motor drives
    C. Three-phase alternating current motors
        a. Rotating magnetic field
        b. Induction motor

c. Squirrel cage induction motor
d. Wound-rotor induction motor
e. Three-phase synchronous motor

D. Single-phase alternating current motors
a. Split-phase motor
b. Split-phase capacitor motor
c. Shaded-pole motor
d. Universal motor

E. Alternating current motor drives
a. Variable-frequency drive
b. Inverter duty motor

F. Motor selection
a. Mechanical power rating
b. Current
c. Code letter
d. Design letter
e. Efficiency
f. Energy-efficient motors
g. Frame size
h. Frequency
i. Full-load speed
j. Load requirements
k. Motor temperature ratings
l. Duty cycle
m. Torque
n. Motor enclosure
o. Metric motors

G. Motor installation
a. Foundation
b. Mounting
c. Motor and load alignment
d. Motor bearings
e. Electrical connections
f. Grounding
g. Conductor size
h. Voltage levels and balance
i. Built-in thermal protection

H. Motor maintenance and troubleshooting
a. Motor maintenance
b. Troubleshooting motors

I. Basic motor control
a. Two-wire on-off control
b. Three-wire on-off control with latching

7. **REPRESENTATIVE METHODS OF INSTRUCTION:**
Typical methods of instruction may include:

A. Other (Specify): This course features two distinct time blocks: lecture and lab. The lecture time block will consist of organized multi-media group presentations, a series of reading assignments in the course textbook, a series of website references that need to be reviewed, homework questions sheets focused on the textbook and web assignments, tracing schematics used to instruct the student in how to follow the path, and analysis activities so that students know the basic math relationships dealing with three-phase power, transformers, generators, and motors. The lab time block will consist of seven organized lab activities focused on single and three-phase power, transformers, generators, and motors. The lab activities will be designed to reinforce lecture theory and encourage troubleshooting skills and techniques. In addition to lecture and lab, the students to explore CBT based activities on the CD-ROM that is available with the course textbook. Using the commercially available program "The Constructor", students will go through a series of computer guided simulation activities covering the main topics of the course. The program has a CAD mode so students can "wire" their circuits and has an interactive mode so that students can "run" their simulated circuits. They can even practice troubleshooting techniques. The course textbook and lab manual include a number of prepared activities and some challenge activities to expand student learning.

8. **REPRESENTATIVE ASSIGNMENTS**
   Representative assignments in this course may include, but are not limited to the following:
   Writing Assignments:
   Write-up Web research worksheets.
   Reading Assignments:
   Weekly assigned readings from textbooks.

9. **REPRESENTATIVE METHODS OF EVALUATION**
   Representative methods of evaluation may include:
   A. Student evaluation will include: grading of homework assignments, grading of lab activities, grading simulation problems, and quiz and test results.

10. **REPRESENTATIVE TEXT(S):**
    Possible textbooks include:
    A. Petruzella, Frank D.,. *Electric Motors and Control Systems*, ed. McGraw-Hill,, 2010
    B. Petruzella, Frank Dl. *Activity Manual for Electric Motors and Control Systems.*, ed. McGraw-Hill, 2010

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Course Originator: Steven Gonzales