C A M O S U N   C O L L E G E

ELECTRONICS & COMPUTER ENGINEERING DEPARTMENT

COURSE OUTLINE

CALENDAR DESCRIPTION

ELEN 148 ELECTRIC MACHINES and CONTROL SYSTEMS
This course initially covers Electrical fundamentals, transformers, DC motors and generators, single and polyphase motors, alternators and systems. Part 2 of this course continues with open- and closed-loop industrial control systems. Topics include synchros and servomechanisms; semi-conductor based power control systems and process control.

OFFERED:	Fall Semester of Program
CREDIT:	6
IN-CLASS WORKLOAD:	6 lecture, 2.5 lab
OUT-OF-CLASS WORKLOAD:	7
PREREQUISITES:	ELEN 141 and ELEN 144

OUTLINE for PART 1:

1. Review of basic electrical concepts including DC, Single and Three-Phase AC.

   1.1. Generation of voltages
   1.1.1. Brushless generator
   1.1.2. Frequency relationship
   1.2. WYE connected generator
   1.3. DELTA connected generator
   1.4. WYE-DELTA and DELTA-WYE systems
   1.5. Phase sequence
   1.6. Power in DC, Single and three-phase systems
   1.7. Iron and amorphous metal based transformers
   1.8. Construction of machines

2. DC Generator Characteristics
   2.1. Induced voltages in series
   2.2. Commutation
   2.3. Dynamo construction
   2.4. Induced voltages, magnetization curve and the build-up process
   2.5. Shunt generator characteristics
   2.6. Compound generator characteristics
   2.7. Effects of armature reaction
   2.8. Commutation
   2.9. Shunt generators in parallel
   2.10. Compound generators in parallel
   2.11. Equalizer connections

3. Direct Current Motors
   3.1. Force on a conductor-magnitude and direction
   3.2. Generation of torque
   3.3. Counter EMF
   3.4. Power conversion
   3.5. Motor speed characteristics
   3.6. Effects of armature reaction
   3.7. Shunt motor characteristics
   3.8. Series motor characteristics
   3.9. Compound motor characteristics

4. Dynamo Efficiency
    - 4.1. Dynamo losses - copper, stray power and stray load
    - 4.2. Determining the stay-power losses
    - 4.3. Method of duplicating flux and speed
    - 4.4. Dynamo efficiency

5. Single Phase Transformers
    - 5.1. Transformer fundamentals
    - 5.2. No-load voltage relations
    - 5.3. Effects of frequency and flux
    - 5.4. No-load phasor diagram
    - 5.5. Current relations
    - 5.6. Phasor diagram with load
    - 5.7. Equivalent transformer circuit
    - 5.8. Full-load phasor diagram
    - 5.9. Transformer regulation
    - 5.10. Transformer efficiency
    - 5.11. Transformer ratings
    - 5.12. Transformer construction
    - 5.13. Polarity and markings
    - 5.14. Single phase transformer connections
    - 5.15. Auto transformers
    - 5.16. Instrument transformers

6. Polyphase Transformer Connections
    - 6.1. The Y-Y transformation
    - 6.2. The Δ-Δ transformation
    - 6.3. The Y-Δ transformation
    - 6.4. The Δ-Y transformation
    - 6.5. The open Δ connection
    - 6.6. Polyphase transformer construction

7. Polyphase Induction Motor
    - 7.1. Construction
    - 7.2. Rotating magnetic field - principles, direction and speed
    - 7.3. Torque at standstill
    - 7.4. Slip
    - 7.5. Rotor EMF, frequency and current
    - 7.6. Running torque, maximum torque
    - 7.7. Description of operation
    - 7.8. Wound rotor induction motor characteristics
    - 7.9. Current and power factor
    - 7.10. Losses and efficiency (theory)
    - 7.11. Selection and operating characteristics of polyphase induction motors

8. Alternators
    - 8.1. Construction
    - 8.2. Frequency of output waveform
    - 8.3. Field construction and excitation
    - 8.4. Generated EMF
    - 8.5. Alternator characteristics
    - 8.6. Armature reaction
    - 8.7. Alternator regulation
    - 8.8. Alternator efficiency
    - 8.9. Alternator ratings
    - 8.10. Voltage regulators

9. Polyphase Synchronous Motor
    - 9.1. Construction
    - 9.2. Principles of operation
    - 9.3. Methods of starting a synchronous motor
    - 9.4. Effect of load
    - 9.5. Variation of field current
    - 9.6. V curves
    - 9.7. Motor ratings and speed control
    - 9.8. Power factor correction

10. Parallel Operation of Alternators
    - 10.1. General introduction
    - 10.2. Requirements for parallel operations
    - 10.3. Synchronizing procedure
    - 10.4. Variation of field current of alternators in parallel
    - 10.5. Dividing load of parallel alternators
    - 10.6. Hunting

11. Single Phase Motors
    - 11.1. Direct current motors operated on alternating current
    - 11.2. Universal motor characteristics
    - 11.3. Single phase induction motor-cross field theory
    - 11.4. Split-phase induction motor characteristics
    - 11.5. Capacitor-start motor characteristics
    - 11.6. Permanent-split capacitor motor
    - 11.7. Two-valve capacitor motor

OUTLINE for PART 2:

1 Introduction to control
    - 1.1 Definition of control
    - 1.2 Control circuit development
    - 1.3 Control devices and application
    - 1.4 Cascading
    - 1.5 Plugging - zero speed controls
    - 1.6 Troubleshooting

2 3ϕ ac motor starters and controllers
    - 2.1 Across line starters
    - 2.2 Resistive and reactor starters
    - 2.3 Wye - delta starters
    - 2.4 Auto-transformer starters
    - 2.5 Closed and open transition
    - 2.6 Braking
    - 2.7 Starters

3 3ϕ variable speed motor drives
    - 3.1 Theory of operation
    - 3.2 Circuit analysis
    - 3.3 Diagnostic equipment

4 Motor starters and controllers
    - 4.1 Voltage drop acceleration
    - 4.2 Series relay acceleration
    - 4.3 Definite time acceleration
    - 4.4 Counter EMF controller
    - 4.5 Dynamic braking

5 Adjustable-speed D.C. drives
- 5.1 Theory of operation
- 5.2 Circuit analysis
- 5.3 Tachometer feedback
- 5.4 Regenerative braking

6 Automated control systems
- 6.1 Automatic control characteristics
  - 6.1.1 Load, lag, stability
- 6.2 Requirements
  - 6.2.1 Stability, accuracy, response
- 6.3 Types of control
  - 6.3.1 Open loop, closed loop
- 6.4 Basic control modes
  - 6.4.1 On-off, proportional, proportional plus integral, proportional plus derivative

7 Final control elements
- 7.1 Motor driven valves
  - 7.1.1 Two-position valves
  - 7.1.2 Proportionally positioned valves
- 7.2 Pneumatic control valves
- 7.3 Servo motors and amplifiers
- 7.4 Synchronous devices
- 7.5 Stepper motors

LAB EXERCISES:

Various lab exercises will be performed to practice and reinforce the lecture material.

STUDENT ASSESSMENT (WEIGHTING)

Assignments/Quizzes:		25%
Labs:		20%
Exams:	Mid-term:	25%
	Final:	30%

COURSE EVALUATION:

Students must achieve a passing grade in both the theory and lab portions of the course in order to pass the entire course. Lab attendance is compulsory and all labs must be completed satisfactorily to pass this course. 40% of the lab mark will be based on preparation, performance and successful completion of each lab.

GRADING (in accordance with College policy):

A+	90 – 100%	B -	70 – 72%
A	85 – 89%	C+	65 – 69%
A -	80 – 84%	C	60 – 64%
B+	77 – 79%	D	50 – 59%
B	73 – 76%	F	< 50%

TEXT & REFERENCES:

Electrical Machines, and Power Systems.
Theodore Wildi - Sixth Edition
Industrial Electronics, Humphries & Sheets
Instructor Handouts