# ENEL 371
# Power and Energy I
# Course Outline Winter 2018

Introduction to concepts of energy and power systems including: single and three phase ac power, delta-wye transformations, protection circuits and safety, transformers, and dc motors.

Prerequisite: ENEL 281 and PHYS 201 or Permission of ESE Program Chair

**Instructor: Irfan Al-Anbagi, Ph.D., P.Eng., SMIEEE**
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**Phone: 585-4703**
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**Office hours: by appointment**

Lectures location and times
Room: ED 230, MW 8:30-9:45 am

**Lab Instructors: Doug Wagner, P.Eng.**
**Office: ED 481**
**Phone: 337-2633**
**E-mail: douglas.wagner@uregina.ca**

Labs location and times
Lab ED 435.2, M 11:30 am –02:15 pm
T 8:30 am – 11:15 am
R 8:30 am-11:15 am
Please check your registration for your specific lab section.

**Recommended text book**:
Electric Machinery and Power System Fundamentals, 1st Edition, Stephen J. Chapman
ISBN-10: 0072291354
ISBN-13: 978-0072291353

**Additional Reading**
Electric Machinery Fundamentals, 4 edition, Stephen J. Chapman
ISBN-10: 0072465239
ISBN-13: 978-0072465235

Fundamentals of Electric Power Engineering: From Electromagnetics to Power Systems, Massimo Ceraolo, Davide Poli
ISBN: 978-1-118-67969-2

Electric Power Systems: A Conceptual Introduction, 1st Edition, Alexandra von Meier
ISBN-13: 978-0471178590
ISBN-10: 0471178594

**Mark Distribution**

Lab 10%
Lab Design Project 20%
Assignments/Quizzes 10%
Midterms 25% (12.5% for each midterm)
Final 35%

**Dates of class tests:**
Midterm #1: Second week of February, 2018
Midterm #2: Second week of March, 2018

**Important Notes:**

- The Lab component of this course must be completed and passed to receive a passing grade in this course (ie. all labs must be completed and submitted).
- If you do not complete the Lab component of the course, you will receive a grade of NP (Not Passed).
- You must pass the exam portion of the course and you must pass the Lab Design Project to receive a passing grade in the course.
- If you do not pass the exam portion of the course and/or do not pass the Lab Design Project, you will receive a grade of NP (Not Passed).
- There will be weekly assignments with the solutions posted on UR Courses.
- Late submissions will receive a mark of 0%.
- Students will submit a softcopy of the Lab design project to Turnitin through UR courses to check the similarity index.

# Course Outline

## Topic 1 Introduction **(Chapter 1_Text book)**

- Electric Machines and Power Systems
- Generators, Transformers, Power Lines
- Loads and Protective Devices, Harmonics
- Real, Reactive, and Apparent Power
- Magnetic Fields, Magnetic Flux Density, Magnetic Circuits
- Energy Losses in a Ferromagnetic Core
- Faraday's Law, Eddy Currents
- Torque, Newton's Law of Rotation

- Induced Force on a Wire

## Topic 2 Three-Phase Circuits **(Chapter 2_Text book)**

- Generation of Three-Phase Voltages and Currents
- Voltages and Currents in a Three-Phase Circuit
- Voltages and Currents in the Wye (Y) Connection
- Voltages and Currents in the Delta (Δ) Connection
- Power Relationships in 3-Phase Circuits
- Instantaneous Power
- Power Relationships in 3-Phase Circuits
- Three-Phase Power Equations Involving Phase Quantities
- Analysis of Balanced Three-Phase Systems

## Topic 3 Transformers **(Chapter 3_Text book)**

- Ideal Transformer
- Power and the Ideal Transformer
- Impedance Transformation
- Theory of Operation of Real Single-Phase Transformers
- Voltage Ratio across a Transformer
- Magnetization Current in a Real Transformer
- Core-loss Current in a Real Transformer
- Excitation Current in a Real Transformer
- Equivalent Circuit of a Transformer
- Open-Circuit Test, Short-Circuit Test
- Transformer Efficiency, Transformer Taps and Voltage Regulation ,
- Autotransformer, Variable Autotransformer
- Three-Phase Transformers, Y – Y Connection, Y-Δ Connection, Δ-Y Connection, Δ-Δ Connection
- Voltage and Frequency Rating, Apparent Power Rating
- Inrush Current

## Topic 4 AC Machinery Fundamentals **(Chapter 4_Text book)**

- Rotating Machines
- The Rotating Magnetic Field, Electrical Frequency and Speed of the Rotating Magnetic Field
- Flux Distribution
- Induced Voltage in a Coil
- Three-Phase Induced Voltages
- Induced Torque in an AC Machine
- Winding Insulation in an AC Machine
- Power Flows and Losses
- Voltage Regulation and Speed Regulation

## Topic 5 Synchronous Machines Overview **(Chapter 5_Text book)**

- Field Current, Speed of Rotation of a Synchronous Generator
- Internal Generated Voltage of a Synchronous Generate
- Synchronous Motor
- Damper Winding

## Topic 6 Induction Motors **(Chapter 7_Text book)**

- Squirrel Cage and Wound Rotors
- Induction Motor Stator, Squirrel Cage Rotor, Squirrel Cage Induction Motor
- Induced Torque in an Induction Motor
- Rotor Slip, Electrical Frequency
- Equivalent Circuit for an Induction Motor
- Losses and Power Flow Diagram
- Power and Torque in an Induction Motor
- Rotor Losses and Power Converted to Mechanical Power
- Torque-Speed Characteristics, Pullout Torque
- Induction Motor Design Classes
- Speed Control of Induction Motors

## Topic 7 Transmission Lines **(Chapter 9_Text book)**

- Overhead lines, Transmission Lines, Resistance
- Inductance and Inductive Reactance, External Inductance Between Two Points
- Inductance of a Single Phase Two Wire Transmission Line
- Understanding the Inductance of a Transmission Line
- Understanding the Inductance of a Transmission Line
- Capacitance and Capacitive Reactance, Capacitance of a Single-Phase Two-Wire Transmission Line
- Understanding the Capacitance of a Transmission Line
- Transmission Line Models, Short Length of Transmission Line
- Medium Length of Transmission Line, Long Length of Transmission Line, The Short Transmission Line
- Transmission Line Characteristics, Effect of Load Changes, Voltage Regulation
- Power Flows, Two-Port ABCD Model

## Topic 8 Electrical Safety: Canadian Electrical Code

**Special Needs Students**

If there is any student in the course who, because of a disability, may have a need for accommodations, please come and discuss it with me, as well as contact the Centre for Student Accessibility at 585-4631.