# NATIONAL UNIVERSITY OF ENGINEERING
# COLLEGE OF MECHANICAL ENGINEERING
# MECHANICAL-ELECTRICAL ENGINEERING PROGRAM

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# ML839 – POWER ELECTRONICS

## I. GENERAL INFORMATION

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| **CODE** | **:** | ML839 Power Electronics |
| **SEMESTER** | **:** | 7 |
| **CREDITS** | **:** | 3 |
| **HOURS PER WEEK** | **:** | 5 (Theory – Practice) |
| **PREREQUISITES** | **:** | ML837 Industrial Electronics |
| **CONDITION** | **:** | Compulsory |

## II. COURSE DESCRIPTION

Theoretical and practical course which includes computer-aided simulation, and exposes to students AC-to-DC power conversion process, single-phase and poly-phase controlled rectifiers. DC-to-AC power conversion, Inverters. AC-to-AC power conversion, stabilizers and cycle-converters. DC-to-DC power conversion, source switching, DC transformers.

## III. COURSE OUTCOMES

1. Learn fundamental concepts of control systems and thyristor firing.
2. Learn fundamental concepts of single-phase, three-phase and poly-phase power systems.
3. Computer-aided analyze and simulate firing and power control systems using SCRs. Single-phase, three-phase and controlled rectified circuits.
4. Computer-aided analyze rectifier, converter, inverter, chopper, single-phase and three-phase circuits.

## IV. LEARNING UNITS

### 1. INTRODUCTION TO FIRING SYSTEMS AND THYRISTOR CONTROL / 10 HOURS

Firing devices: DIAC, UJT, PUT, special integrated circuits, application circuits. Power-control devices: Thyristors, SCR, TRIAC, Opto-isolators, LASCR.

### 2. SYSTEMS MODELING / 5 HOURS

Voltages and currents in a three-phase circuit. Star (Y) and Delta (Δ) connection. Power rations in three-phase circuits.

### 3. AC/DC POWER CONTROL SYSTEM ANALYSIS / 20 HOURS

AC/DC power conversion: Single-phase controlled rectifier, R and RL charges; Three-phase controlled rectifiers, R, RL, RLE charge. Single-phase unidirectional regulator, Phase control principle, resistive charge, single-phase bidirectional regulator, resistive charge, inductive charge. Three-phase unidirectional regulator, resistive charge: Star (Y) connection, Delta (Δ) connection. Three-phase bidirectional regulator, resistive charge: Star (Y) connection, Delta (Δ) connection.

**4. ANALYSIS OF CC/CC and AC/AC CONVERTERS / 20 HOURS**

CC/CC converters, introduction, control circuits, pulse-width modulation (PWM), PWM commutation, Buck converter, boost converter, buck/boost converter, Ćuk converter. AC/AC converters, On-off control, phase control, Bidirectional and half wave controllers. Inverters, introduction, applications, basic concepts of commuted and single-phase half-bridge inverters, PWM commutation.

**5. ANALYSIS OF INVERTER SYSTEMS AND FREQUENCY AND VOLTAGE CONTROLLERS / 4 HOURS**

Square wave inverters, resonant inverter, Single-phase full-bridge inverter, Bipolar-voltage commutation PWM inverter, Unipolar-voltage commutation PWM inverter, Single-phase and three-phase controllers. Frequency and Voltage Controllers. Cascade converters, cyclo-converter, general concepts about controllers, charge coupling, the motor and the controller, several controller configurations.

## V. LABORATORY EXPERIENCES

**Lab 1**: Analysis of alternative energies and (Solar cells and wind power)
**Lab 2**: batteries.
**Lab 3**: AC/DC – DC/AC Converters.

## VI. METHODOLOGY

The course is carried out in computing lab, theory and practice sessions. In theory sessions, the instructor introduces concepts, theorems and applications. In practice sessions, several problems are solved, and their solutions are analyzed. In lab sessions, simulation software is used to solve problems and analyze their solutions. During lab sessions students must work out, hand in and expose a project. In all sessions student's active participation is encouraged.

## VII. EVALUATION FORMULA

The average grade PF is calculated as follows:

**PF = 0.25EA + 0.25EB + 0.25(PC1+PC2+PC3)/3 + 0.25(LB1+LB2+LB3)/3**

EA: Mid-Term Exam EB: Final Exam
PC: Quizzes LB: Labs

## VIII. BIBLIOGRAPHY


1. **RASHID, MUHAMMAD H.**
   Power Electronics, Circuits, Devices and Applications (Spanish)
   Pearson Education, 2010

2. **HART W. DANIEL**
   Power Electronics
   Pearson Education, 2006