# NATIONAL UNIVERSITY OF ENGINEERING
## COLLEGE OF PETROLEUM AND PETROCHEMICAL ENGINEERING
## PETROLEUM ENGINEERING PROGRAM

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# PP424 – OIL PRODUCTION II

## I. GENERAL INFORMATION

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| **CODE** | **:** | PP424 Oil Production II |
| **SEMESTER** | **:** | 8 |
| **CREDITS** | **:** | 5 |
| **HOURS PER WEEK** | **:** | 6 (Theory–Practice) |
| **PREREQUISITES** | **:** | PP414 Oil Production I |
| **CONDITION** | **:** | Compulsory |
| **DEPARTMENT** | **:** | Petroleum and Natural Gas Engineering |

## II. COURSE DESCRIPTION

The course prepares students to apply the concepts, methods and techniques for the production of oil from emerging and non-emerging wells, involving interconnected systems that include the reservoir and artificial structures from the well to the production battery. Students understand and apply the methods of artificial lifting such as mechanical pumping, continuous and intermittent pneumatic pumping, hydraulic pumping, electro-submersible pumping. Students are prepared for the design and implementation of proper methods according to reservoir actual conditions.

## III. COURSE OUTCOMES

At the end of the course, students:

1. Understand and compare the different types of artificial lifting systems in oil wells.
2. Select and apply the proper system according to the available information and well actual conditions.
3. Characterize oil wells to select the suitable hoisting system.
4. Design and implement the installations of artificial lifting systems.
5. Interpret the production performance of wells according to their main characteristics.
6. Optimize the operation of artificial lifting systems in oil wells.
7. Interpret the use of production gradient curves in the design of artificial lifting systems.

## IV. LEARNING UNITS

### 1. ARTIFICIAL LIFTING SYSTEMS

Use of artificial lifting systems / Pneumatic, mechanical, hydraulic and electro-submersible pumping / Gas lift or pneumatic pumping: Characteristics of reservoirs / Characteristics and requirements to design a gas lift installation.

### 2. PNEUMATIC PUMPING OR GAS LIFT

Types of installation / Continuous and intermittent pneumatic pumping / Gas lift valves. Features / Well "Shock" and "Boot" in gas lift / Gas lift valves: opening and closing forces / Calculation of opening and closing pressure of valves / Spread / Fluids used to "kill" a well / Design of a conventional installation of gas lift based on opening pressures / Concentric installation / Parallel installation / Efficiencies.

**Continuous gas lift.** Static gradient / Use of gradient curves / Graphic method for determining the equilibrium and injection points / Determination of injection GLR.

**Intermittent gas lift.** Determination of injection cycle / Injection time / Required injection volume for an efficient lifting / "Fall Back"

Design of a conventional installation based on closing pressures / Gas lift in directed wells / Compressors / Functions / Capacity and power / Consumption.
**Chamber installation.** Calculation of the chamber length / Depth of operating valve / Efficiency / Surface injection control systems / Injection time control.

3. **MECHANICAL PUMPING**
   Introduction / Components of a mechanical pumping system / Types of underground pumps / Surface equipment / Selection of surface pumping system / Analysis of pumping system / Piston effective displacement of an underground pump / Loads in the polished rod.

4. **DESIGN OF MECHANICAL PUMPING RODS STRING**
   Fluid loads / Weight of the rods string / Acceleration loads / Maximum load / Minimum load / Simple and combined strings / Calculation of each section length.

5. **PUMP DISPLACEMENT**
   Production rate / Volumetric efficiency / Design of equilibrium system (rocker) / Ideal effects of the equilibrium system / Calculation of counterweight and its location / Torque calculation.

6. **ENGINE POWER REQUIREMENTS**
   Speed reduction / Hydraulic power / Net lifting power / Energy losses by friction / Break power / Selection of a surface engine / Expected production vs. Pump depth / Displacement length of the polished rod.

7. **PUMPING SPEED**
   Calculation of pumping speed / Use of tables and graphs / Factors causing problems in the rods string and production tubing / Synchronism / Dynamometer / Use of dynamometer / Measurement interpretation.

8. **HYDRAULIC PUMPING**
   Pascal principle / Characteristics of pumping system / Types of installations / Parallel installations / Hydraulic pumping / Design of a typical system / Fluid drive / Efficiency / Displacement / Pressure losses / Selection of underground pumping system / Returning fluid / Pressure losses in return / Balance of pressures / Selection of surface pumping system / Pumping speed / Pump power / Engine power.

9. **ELECTRO-SUBMERSIBLE PUMPING**
   System characteristics / Components of the system / Voguel law / Two phases flow / Design of pumping system / Work rate / Pressure losses / Use of separators / Selection of underground pumping system / Use of tables and graphs / Determination of required number of stages / Braking power / Selection of the cable and surface control system / Selection of an artificial lifting system according to technical–economic parameters.

## V. METHODOLOGY

The course takes place in theory, practice and laboratory sessions. In the theory sessions, the teacher presents concepts and applications. In practice sessions, the design of artificial lifting systems is completed for different wells conditions. At the end of the course, students complete a project and defend it. Student's active participation is promoted.

## VI. GRADING FORMULA

The Final Grade PF is calculated as follow:

**PF = (EP + EF + PC + PL) / 4**

EP: Mid-term Exam EF: Final Exam
PC: Practical Work PL: Laboratory Practice

## VII. BIBLIOGRAPHY


1. CRAFT
   Petroleum Production Systems
2. KERMIT BROWN
   Petroleum Practices
3. CAMCO
   Gas Lift Manual