UNIVERSITY OF MISKOLC
FACULTY OF **EARTH SCIENCE AND ENGINEERING**
1735

ARTIFICIAL LIFTING I.

MSc in Petroleum Engineering **MFKOT720017**

COURSE DESCRIPTION

University of Miskolc
Faculty of Earth Science and Engineering
Petroleum and Natural Gas Institute
September 2022

Course Data Sheet

Course Title: Artificial Lifting I **Instructor:** Dr. Gábor TAKÁCS professor emeritus	**Code:** MFKOT720017 **Responsible department/institute:** DPE/IPNG (OMTSZ/KFGI) **Course Element: Compulsory**
Position in curriculum* (which semester): 3 (2)	**Pre-requisites (if any):** Production engineering fundamentals (MFKOT720025)
No. of contact hours per week (lecture + seminar): 2+2	**Type of Assessment (examination / practical mark / other):** examination
Credits: 6	**Course:** full time

Course Description:

1. Introduction to artificial lifting: history, main features, comparison.
2. Components of the sucker-rod pumping system: downhole pumps, sucker-rod string.
3. Mechanical design of the sucker-rod string, failure modes.
4. Surface equipment, pumping units, unit geometries.
5. Kinematics of pumping units. Gearboxes, prime movers.
6. Calculation of operational parameters of rod pumping: approximate models.
7. Dynamics of rod strings.
8. The API RP 11L model: calculation accuracy, application ranges.
9. Simulation of the sucker-rod string's behavior.
10. Forms of the one-dimensional wave equation, solution methods, calculation of downhole cards.
11. Torsional analysis of pumping units, optimum counterbalancing.
12. Design of the pumping system, selection of the optimum pumping mode.
13. Intermittent pumping.
14. Analysis of the pumping system's operation: well testing, the use of dynamometers, evaluation of dynamometer cards.

Competencies to evolve:

Knowledge:

Knows the economic processes related to the hydrocarbon industry.

Knows the processes and phenomena occurring during production in petroleum and natural gas water wells.

Knows the equipment used for different types of production; and the methods ensuring the appropriate selection of the necessary equipment and procedures.

Knows the methods and tools of computerized design and analysis in the hydrocarbon industry.

Ability:

Able to interpret the economic processes related to the hydrocarbon industry and to give adequate answers to them.

Capable of monitoring and forecasting the processes taking place in oil and natural gas water wells.

Able to choose the optimal production method, design and select the production equipment.

Able to supervise and inspect equipment related to pipeline transportation of crude oil, natural gas and water.

Able to select equipment for field and transmission line transport and supervise the operation of the equipment and manage the participating groups.

Capable of hydrocarbon industrial computer design and analysis.

Autonomy and responsibility:

Able to independently manage hydrocarbon industrial complex planning works and perform project management tasks, or participate in them.

Autonomously able to plan the production of fluid-producing wells, to achieve optimal production conditions; for the appropriate selection of the necessary equipment and procedures; to implement solutions that ensure maximum profit.

Able to autonomously plan the use of energy carriers produced from renewable natural resources and residual materials in the energy supply system, and manage the operation of the established system.

Takes responsibility for his/her professional decisions and the work processes carried out by him/her or under his/her control.

Assessment and grading:	Grading scale:

Students will be assessed with using the following elements.		% value	Grade
Attendance:	5 %	90 -100%	5 (excellent)
Homework	10 %	80 – 89%	4 (good)
Midterm exam	40 %	70 - 79%	3 (satisfactory)
Final exam	45 %	60 - 69%	2 (pass)
Total	100%	0 - 59%	1 (failed)

Compulsory or recommended literature resources:

- Takács G.: Basic sucker rod pumping. Miskolc, ME, 1992. 321 p.
- Takács G.: Sucker-rod pumping manual. Tulsa : PennWell, 2003. 395 p. ISBN 0 87814 899 2
- G. Takács: Modern sucker-rod pumping. Tulsa : PennWell, 1993. 230 p. ISBN 0 87814 383 1
- Production Operations Engineering, Petroleum Engineering Handbook Vol 4, SPE, 2006
- George V.Chilingarian et.al.: Surface Operations in Petroleum Production II, Elsevier, 1989.

Szilas, A.P.: Production and Transport of Oil and Gas. Part B., Akadémiai Kiadó, Budapest, 1986., ISBN 963-05-3363-4

Course Schedule for 2022/23 school year, fall term

Date	Topic
9/8/2022	Introduction to artificial lifting: history, main features, comparison.
9/8/2022	Components of the sucker-rod pumping system: downhole pumps, sucker-rod string.
9/22/2022	Mechanical design of the sucker-rod string, failure modes.
9/29/2022	Surface equipment, pumping units, unit geometries.
10/6/2022	Kinematics of pumping units. Gearboxes, prime movers.
10/13/2022	Calculation of operational parameters of rod pumping: approximate models. Dynamics of rod strings.
10/20/2022	Test writing.
11/3/2022	The API RP 11L model: calculation accuracy, application ranges.
11/3/2022	Simulation of the sucker-rod string's behavior.
11/10/2022	Forms of the one-dimensional wave equation, solution methods, calculation of downhole cards.
11/17/2022	Torsional analysis of pumping units, optimum counterbalancing.
11/24/2022	Design of the pumping system, selection of the optimum pumping mode.
12/1/2022	Intermittent pumping. Analysis of the pumping system's operation: well testing, the use of dynamometers, evaluation of dynamometer cards.
12/8/2022	Test writing.

Test Example

CLOSED BOOK

NAME of STUDENT: _____ ID No.:_____

Problem Statement :

Calculate and plot the true and effective static loads for the down-, and upstroke in the rod string for the well given.

Pump Setting Depth=8,000 ft Dynamic Level=8,000 ft Wellhead Pressure=100 psi

Liquid Sp.Gr.=1.0 Plunger Size=1 1/4"

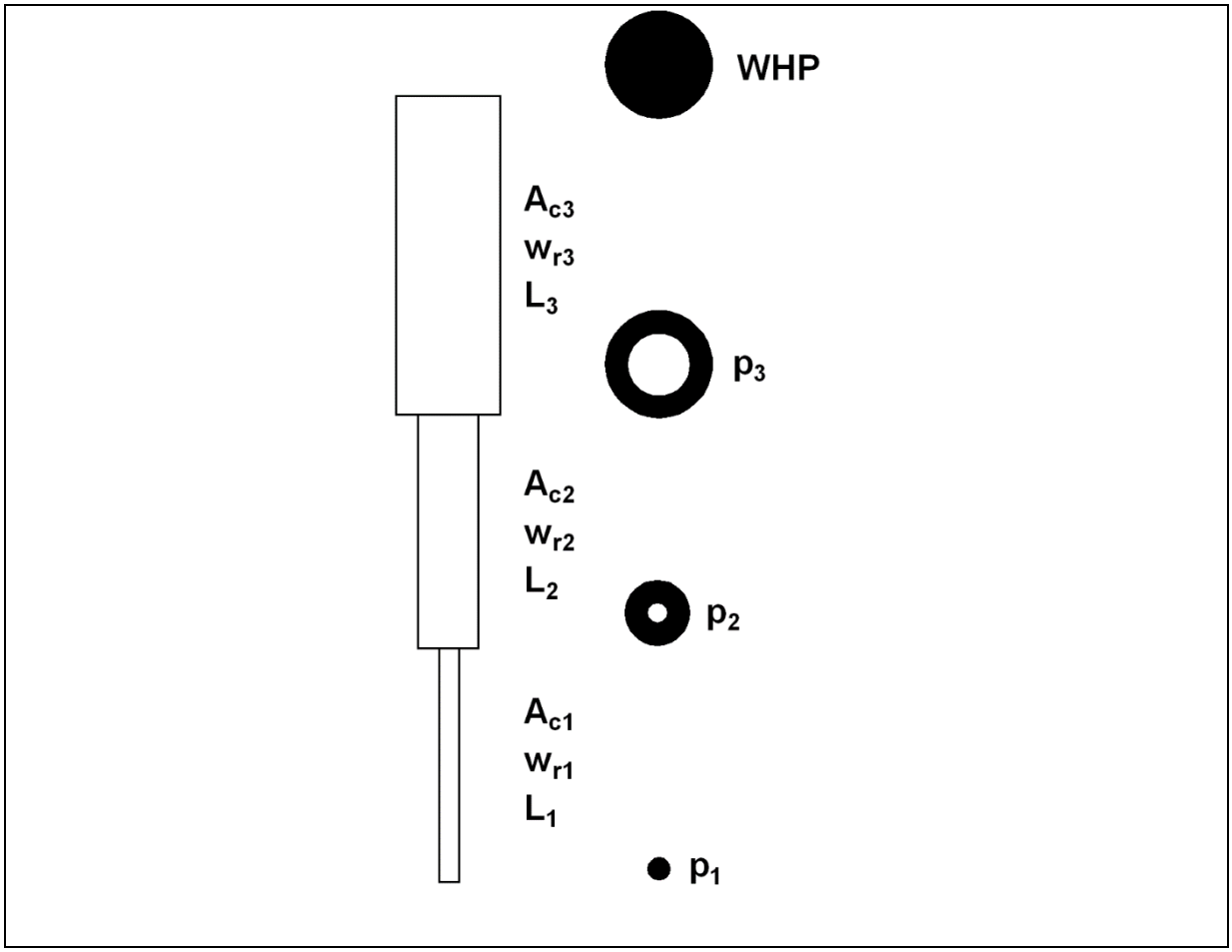
Steel Rod String: 2,223 ft of 7/8',
2,571 ft of 3/4", and
3,206 ft of 5/8" rods.

Instructions :

First calculate the downstroke static loads with the help of the sketch provided.

Effective Load = True Load + p A_{cr}

Solution :



p_1 = _____

p_2 = _____

p_3 = _____

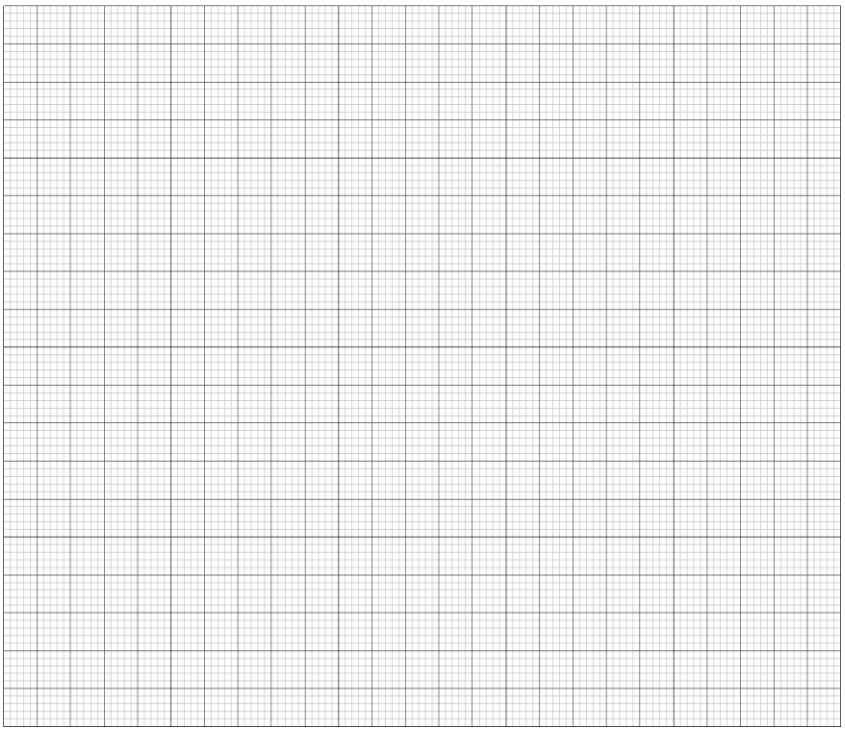
Fluid Load = _____

“I pledge that I have neither given nor received any unauthorized assistance on this exam.”

Student’s Signature: _____

	DOWNSTROKE		UPSTROKE	
	TRUE	**EFFECTIVE**	**TRUE**	**EFFECTIVE**
Taper #1 bottom				
Taper #1 top				
Taper #2 bottom				
Taper #2 top				
Taper #3 bottom				
Taper #3 top				

Plot your results on the chart provided.



Examination review questions

Artificial Lifting Types, Features
API Subsurface pumps and their features.
Non-API Subsurface pumps and their features.
Downhole gas separation, gas separator types
Sucker rod types, materials
The design of sucker rod strings.
Pumping units, their construction and kinematic parameters
The API RP 11L method
Simulation of the sucker-rod string's behavior
Torsional loading on speed reducers
Power requirements of rod pumping
The design of the pumping system, intermittent pumping
Analysis of rod pumping installations
The Basics of Dynamometry