



39. Course Specification of Hydraulic and Pneumatic Systems

I. Course Identification and General Information:						
.1	Course Title:	Hydraulic and Pneumatic Systems.				
.2	Course Code & Number:	MT212.				
.3	Credit hours:	C.H				TOTAL CR. HRS.
		Th.	Seminar	Pr	Tu.	
		2	-	2	-	
.4	Study level/ semester at which this course is offered:	Third Year-Second Semester.				
.5	Pre –requisite (if any):	Fluid Mechanics, Electrical Circuits (1), Electrical Circuits (2) and Analog Control System.				
.6	Co –requisite (if any):	None.				
.7	Program (s) in which the course is offered:	Mechatronics Engineering Program.				
.8	Language of teaching the course:	English Language.				
.9	Location of teaching the course:	Mechatronics Engineering Department.				
10.	Prepared By:	Asst. Prof. Dr. Eng. Hamoud A. Al-Nahari.				
11.	Date of Approval:					

II. Course Description:		
<p>This course introduces the basic components and functions of hydraulic and pneumatic systems. Topics include standard symbols, pumps, valves, actuators, FRL, maintenance procedures. The control of Hydraulic and Pneumatic Systems and maintenance procedures are introduced. Upon completion, students should be able to understand the operation of a fluid power system, including design, application, and troubleshooting.</p>		
III. Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1.	Describe the basic concepts of hydraulics and pneumatics system components.	A2
a2.	Depict the operation of systems used to control the fluid power systems.	
b1.	Explore appropriate solutions to design and trouble-shooting of fluid power systems.	B1

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Dr. Abdul-Malik Momin

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Assoc. Prof. Dr.
Mohammad Algorafi

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Mohammed AL-Bukhaiti

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b2.	Analyze the software solutions associated with hydraulic and pneumatic systems applications.	
c1.	Choose hydraulic and pneumatic components and circuits from practical point of view.	C1
c2.	Demonstrate hardware associated with hydraulic and pneumatic systems applications.	
d1.	Cooperate in work successfully as a part of a team and prepare the presentations and reports with all facilities.	D1
d2.	Justify results and defend different ideas.	D6

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
Describe the basic concepts of hydraulics and pneumatics system components. a1.	Active Lectures, Seminars.	Written Assessments.
Depict the operation of systems to control the fluid power systems. a2.		

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
Explore appropriate solutions to design trouble-shooting of fluid power and systems. b1.	Active Lectures, Seminars.	Written Assessments.
Analyze the software solutions associated with hydraulic and pneumatic systems applications. b2.		

(C) Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
Choose hydraulic and pneumatic components and circuits from practical point of view. c1.	Laboratory Work, Simulations using	Practical Assessment, Project Reports,

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Dr. Abdul-Malik Momin

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Demonstrate hardware associated with hydraulic and pneumatic systems applications.	c2.	Computer Software.	Laboratory Reports.
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(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
Cooperate in work successfully as a part of a team and prepare the part and reports with all presentations facilities.	Laboratory Work, Simulations using Computer Software.	Project Reports, Laboratory Reports, Presentations, Practical Assessment.
Justify results and defend different ideas.		

IV. Course Content:					
A – Theoretical Aspect:					
Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Basic Concepts of Hydraulics.	a1, a2, b1, b2.	<ul style="list-style-type: none"> Introduction & Definitions of important terms like Hydraulics, Pressure, Force, Vacuum etc. Pascal's Law and its Application to Hydraulics. Advantages and Disadvantages of Hydraulic System. Hydraulic Oil; Purpose of Hydraulic Oil, Ideal Characteristics of Hydraulic Oil, Maintenance of Hydraulic Oil. 	1	2
2.	Hydraulic Pumps and Motors.	a1, a2, b1, b2.	<ul style="list-style-type: none"> Pump Specifications. Construction & Working of; Gear Pump, Vane Pump, Radial Piston Pump. 	2	4

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Dr. Abdul-Malik Momin

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			<ul style="list-style-type: none"> • Pump Maintenance & Trouble Shooting. • Hydraulic Motor Specifications. • Construction & Working of; Gear Motor, Vane Motor, Radial Piston Motor. • Hydrostatic Transmissions. 		
3.	Hydraulic Actuators.	a1, a2, b1, b2, c1, c2, d1, d2.	<ul style="list-style-type: none"> • Linear. • Rotary. 	1	2
4.	Hydraulic Valves.	a1, a2, b1, b2, c1, c2, d1, d2.	<ul style="list-style-type: none"> • Directional Control Valves. • Pressure Control Valves. • Flow Control Valves. 	2	4
5.	Hydraulic Circuits and Simulation.	a1, a2, b1, b2, c1, c2, d1, d2.	<ul style="list-style-type: none"> • Simulation using Automation Studio Software. • Regenerative Cylinder Circuit. • Pump-Unloading Circuit. • Hydraulic Cylinder Sequencing Circuit. • Cylinder Synchronizing Circuit. • Fail-Safe Circuit. • Speed Control of Hydraulic Cylinder and Motor. 	2	4
6.	Mid-Term Exam.	a1, a2, b1, b2, c1, c2.	• The First 5 Chapters.	1	2
7.	Ancillary Hydraulic Devices.	a1, a2, b1, b2, c1, c2, d1, d2.	<ul style="list-style-type: none"> • Reservoir. • Accumulator. • Pressure Intensifier. • Sealing Devices. • Heat Exchangers. • Pressure Gages. • Flowmeters. 	1	2
8.	Introduction to Pneumatics.	a1, a2, b1, b2, c1, c2, d1, d2.	<ul style="list-style-type: none"> • Principles of Pneumatics. • Comparison with Hydraulic System. • Physical law of pneumatics. 	1	2

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Quality Assurance Unit
Assoc. Prof. Dr.
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			<ul style="list-style-type: none"> Gas law and various processes. Air Compressors: Single Acting and Double Acting. Components of Pneumatics System. Air receiver and pressure control. Stages of Air Treatment; Intercooler, Lubricator, Filter, Air dryer. 		
9.	Pneumatic components.	a1, a2, b1, b2, c1, c2, d1, d2.	<ul style="list-style-type: none"> Actuator and output Device. Valves and control Valves: Directional control valve, pressure control valve, solenoid valve. Sensor: Type and characteristics of sensors. 	1	2
10.	Pneumatic Circuits and Simulation.	a1, a2, b1, b2, c1, c2, d1, d2.	<ul style="list-style-type: none"> Basic Pneumatic Circuits. Pneumatic Vacuum System. Gas Loaded Accumulators. 	1	2
11.	Controls of Hydraulic and Pneumatic Circuits.	a1, a2, b1, b2, c1, c2, d1, d2	<ul style="list-style-type: none"> Electrical Controls. Logic Control. Advanced Electrical Controls 	2	4
12.	Final Exam.	a1, a2, b1, b2, c1, c2.	All the Chapters.	1	2
Number of Weeks /and Units Per Semester				16	32

B - Practical Aspect: (Lab)				
Order	Tasks/ Experiments	Number of Weeks	Contact hours	Learning Outcomes
1.	Introduction to Hydraulic Trainer.	1	2	a1, a2, b1, b2, c1, c2, d1, d2.
2.	Sequential Control of a 2 Double-acting Cylinders.	1	2	a1, a2, b1, b2, c1, c2, d1, d2.
3.	Regenerative and Parallel Circuits.	1	2	a1, a2, b1, b2, c1, c2,

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Dr. Abdul-Malik Momin

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Algorafi

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				d1, d2.
4.	Hydraulic Motor Circuits.	2	4	a1, a2, b1, b2, c1, c2 d1, d2.
5.	Safety Circuits.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
6.	Pneumatic Control of a Double-acting Cylinders.	2	4	a1, a2, b1, b2, c1, c2, d1, d2.
7.	Electro Pneumatics Control Technology.	2	4	a1, a2, b1, b2, c1, c2, d1, d2.
8.	Electro Pneumatics Sequential Control of a 2 Double acting Cylinders.	2	4	a1, a2, b1, b2, c1, c2, d1, d2.
9.	Pneumatic Sequential Control of a 3 Double acting Cylinders.	1	2	a1, a2, b1, b2, c1, c2, d1, d2.
10.	Electro Pneumatic Sequential Control of a 3 Double acting Cylinders.	1	2	a1, a2, b1, b2, c1, c2, d1, d2.
Number of Weeks /and Units Per Semester		14	28	

VI. Teaching strategies of the course:

- Active Lectures.
- Seminars.
- Laboratory Work.
- Simulation using Computer Software.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Exercises & Home works (All the above Chapters).	a1, a2, b1, b2, c1, c2, d1, d2.	Weekly	10
2.	Project (single/group).	a1, a2, b1, b2, c1, c2, d1, d2.	13	5
Total				15

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Exercises & Home Works.	Weekly	15	10 %	a1, a2, b1, b2, c1, c2, d1, d2.

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Assoc. Prof.
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Quality Assurance Unit
Assoc. Prof. Dr.
Mohammad Algorafi

Dean of the Faculty
Prof. Dr.
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2.	Project (single/group).	13	7.5	5 %	a1, a2, b1, b2, c1, c2, d1, d2.
3.	Quiz 1 and Quiz 2.	8 and 12	7.5	5 %	a1, a2, b1, b2, c1, c2, d1, d2.
4.	Lab. Assessment.	12-14	15	10%	a1, a2, b1, b2, c1, c2, d1, d2.
5.	Mid-Term Exam.	9	15	10 %	a1, a2, b1, b2, c1, c2, d1, d2.
6.	Final Exam (theoretical).	16	90	60 %	a1, a2, b1, b2, c1, c2, d1, d2.
Total			150	100%	

IX. Learning Resources:

- Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).

1- Required Textbook(s) (maximum two).

1. Anthony Esposito, 2014, "Fluid Power with Applications", Prentice Hall.
Andrew Parr, 1998, "Hydraulics and Pneumatics", Elsevier (Third Edition). 2.

2- Essential References.

1. Dudleyt, A. Pease and John J. Pippenger, 1987, " Basic Fluid Power ", Prentice Hall.
2. Andrew Parr, 1999, " Hydraulics and Pneumatics ", Jaico Publishing House.
3. Johnson, James L. Introduction to Fluid Power. ISBN 107668-2365-2.
4. Michael J. , Pinches and John G. Ashby, 1989, " Power Hydraulics ", Prentice Hall.

3- Electronic Materials and Web Sites etc.

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|---|----|
| Interactive Animation of Hydraulic Systems: | 1. |
| http://home.wxs.nl/~brink494/frm_e.htm | |
| Glossary of Pumps Animation. | 2. |
| http://www.animatedsoftware.com/pumpglos/pumpglos.ht | |
| The Fluid Power Journal: http://www.fluidpowerjournal.com/ | 3. |

Head of the
Department
Assoc. Prof.
Dr. Abdul-
Malik Momin

Quality Assurance
Unit
Assoc. Prof. Dr.
Mohammad
Algorafi

Dean of the
Faculty
Prof. Dr.
Mohammed AL-
Bukhaiti

Academic Development
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Assoc. Prof. Dr. Huda Al-
Emad

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X.Course Policies:	
.1	<p style="text-align: right;">Class Attendance:</p> <p>attendance according to rules and regulations of the The students should have more than 75 % of Faculty.</p>
.2	<p style="text-align: right;">Tardy:</p> <p>The students should respect the timing of attending the lectures. They should attend within 10 minutes from starting of the lecture.</p>
.3	<p style="text-align: right;">Exam Attendance/Punctuality:</p> <p>The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final exam.</p>
.4	<p style="text-align: right;">Assignments & Projects:</p> <p>The assignment is given to the students after each chapter, the student has to submit all the assignments for checking on time.</p>
.5	<p style="text-align: right;">Cheating:</p> <p>If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquiries .</p>
6.	<p style="text-align: right;">Plagiarism:</p> <p>The student will be terminated from the Faculty, if one student attends the exam on another behalf according to the policy, rules and regulations of the university.</p>
7.	<p style="text-align: right;">Other Policies:</p> <ul style="list-style-type: none"> • All the teaching materials should be kept out the examination hall.

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Department
Assoc. Prof.
Dr. Abdul-
Malik Momin

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Mohammad
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Mohammed AL-
Bukhaiti

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	<ul style="list-style-type: none">• The mobile phone is not allowed.• There should be a respect between the student and his teacher.
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Reviewed By	Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat. President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi. Head of Mechatronics Engineering Department: Assoc. Prof. Dr. Abdul-Malik Momin.
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Head of the
Department
Assoc. Prof.
Dr. Abdul-
Malik Momin

Quality Assurance
Unit
Assoc. Prof. Dr.
Mohammad
Algorafi

Dean of the
Faculty
Prof. Dr.
Mohammed AL-
Bukhaiti

Academic Development
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Assoc. Prof. Dr. Huda Al-
Emad

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Mohammed Abbas



Course Plan of Hydraulic and Pneumatic Systems

I. Information about Faculty Member Responsible for the Course:								
Name of Faculty Member	Asst. Prof. Dr. Eng. Hamoud A. Al-Nahari.		Office Hours					
Location & Telephone No.			SAT	SUN	MON	TUE	WED	THU
E-mail	h_nahary@hotmail.com							

II. Course Identification and General Information:						
1.	Course Title:	Hydraulic and Pneumatic Systems.				
2.	Course Number & Code:	MT212.				
3.	Credit hours:	C.H				Total Cr. Hrs.
		Th.	Seminar	Pr.	Tu.	
		2	-	2	-	3
4.	Study level/year at which this course is offered:	Third Year- Second Semester.				
5.	Pre –requisite (if any):	Fluid Mechanics, Electrical Circuits (1), Electrical Circuits (2) and Analog Control System.				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Mechatronics Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	System of Study:	Semesters.				
10.	Mode of delivery:	Lectures and Lab.				
11.	Location of teaching the course:	Mechatronics Engineering Department.				

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Assoc. Prof.
Dr. Abdul-Malik Momin

Quality Assurance Unit
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Mohammad Algorafi

Dean of the Faculty
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Mohammed AL-Bukhaiti

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III.Course Description:				
This course introduces the basic components and functions of hydraulic and pneumatic systems. Topics include standard symbols, pumps, valves, actuators, FRL, maintenance procedures. The control of Hydraulic and Pneumatic Systems and maintenance procedures are introduced. Upon completion, students should be able to understand the operation of a fluid power system, including design, application, and troubleshooting.				
IV.Course Intended learning outcomes (CILOs) of the course				Referenced PILOs
a1.	Describe the basic concepts of hydraulics and pneumatics system components.			A2
a2.	Depict the operation of systems used to control the fluid power systems.			
b1.	Explore appropriate solutions to design and trouble-shooting of fluid power systems.			B1
b2.	Analyze the software solutions associated with hydraulic and pneumatic systems applications.			
c1.	Choose hydraulic and pneumatic components and circuits from practical point of view.			C1
c2.	Demonstrate hardware associated with hydraulic and pneumatic systems applications.			
d1.	Cooperate in work successfully as a part of a team and prepare the presentations and reports with all facilities.			D1
d2.	Justify results and defend different ideas.			D6
V.Course Content:				
A – Theoretical Aspect:				
Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1.	Basic Concepts of Hydraulics.	<ul style="list-style-type: none"> • Introduction & Definitions of important terms like Hydraulics, Pressure, Force, Vacuum etc. • Pascal's Law and its Application to Hydraulics. • Advantages and Disadvantages of Hydraulic System. 	1	2

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		<ul style="list-style-type: none"> Hydraulic Oil; Purpose of Hydraulic Oil, Ideal Characteristics of Hydraulic Oil, Maintenance of Hydraulic Oil. 		
2.	Hydraulic Pumps and Motors.	<ul style="list-style-type: none"> Pump Specifications. Construction & Working of; Gear Pump, Vane Pump, Radial Piston Pump. Pump Maintenance & Trouble Shooting. Hydraulic Motor Specifications. Construction & Working of; Gear Motor, Vane Motor, Radial Piston Motor. Hydrostatic Transmissions. 	2,3	4
3.	Hydraulic Actuators.	<ul style="list-style-type: none"> Linear. Rotary. 	4	2
4.	Hydraulic Valves.	<ul style="list-style-type: none"> Directional Control Valves. Pressure Control Valves. Flow Control Valves. 	5,6	4
5.	Hydraulic Circuits and Simulation.	<ul style="list-style-type: none"> Simulation using Automation Studio Software. Regenerative Cylinder Circuit. Pump-Unloading Circuit. Hydraulic Cylinder Sequencing Circuit. Cylinder Synchronizing Circuit. Fail-Safe Circuit. Speed Control of Hydraulic Cylinder and Motor. 	7,8	4
6.	Mid-Term Exam.	The F irst 5 C hapters.	9	2
7.	Ancillary Hydraulic Devices	<ul style="list-style-type: none"> Reservoir. Accumulator. Pressure Intensifier. Sealing Devices. Heat Exchangers. 	10	2

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		<ul style="list-style-type: none"> Pressure Gages. Flowmeters. 		
8.	Introduction to Pneumatics.	<ul style="list-style-type: none"> Principles of Pneumatics. Comparison with Hydraulic System. Physical law of pneumatics. Gas law and various processes. Air Compressors: Single Acting and Double Acting. Components of Pneumatics System. Air receiver and pressure control. Stages of Air Treatment; Intercooler, Lubricator, Filter, Air dryer. 	11	2
9.	Pneumatic Components.	<ul style="list-style-type: none"> Actuator and output Device. Valves and control Valves: Directional control valve, pressure control valve, solenoid valve. Sensor: Type and characteristics of sensors. 	12	2
10.	Pneumatic Circuits and Simulation.	<ul style="list-style-type: none"> Basic Pneumatic Circuits. Pneumatic Vacuum System. Gas Loaded Accumulators. 	13	2
11.	Controls of Hydraulic and Pneumatic Circuits.	<ul style="list-style-type: none"> Electrical Controls. Logic Control. Advanced Electrical Controls 	14,15	4
12.	Final Exam.	All the Chapters.	16	2
Number of Weeks /and Units Per Semester			16	32
B - Practical Aspect: (Lab)				
Order	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes
1.	Introduction to Hydraulic Trainer.	1	2	a1, a2, b1, b2, c1, c2, d1, d2.
2.	Sequential Control of a 2 Double - acting Cylinders.	2	2	a1, a2, b1, b2, c1, c2, d1, d2.
3.	Regenerative and Parallel Circuits.	3	2	a1, a2, b1, b2, c1, c2,

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Mohammad
Algorafi

Dean of the Faculty
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Mohammed AL-Bukhaiti

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				d1, d2.
4.	Hydraulic Motor Circuits.	4,5	4	a1, a2, b1, b2, c1, c2 d1, d2.
5.	Safety Circuits.	6	2	a1, a2, b1, b2, c1, c2, d1, d2
6.	Pneumatic Control of a Double-acting Cylinder.	7,8	4	a1, a2, b1, b2, c1, c2, d1, d2.
7.	Electro Pneumatics Control Technology.	9,10	4	a1, a2, b1, b2, c1, c2, d1, d2.
8.	Electro Pneumatics Sequential Control of a 2 Double-acting Cylinders.	11,12	4	a1, a2, b1, b2, c1, c2, d1, d2.
9.	Pneumatic Sequential Control of a 3 Double-acting Cylinder.	13	2	a1, a2, b1, b2, c1, c2, d1, d2.
10.	Electro Pneumatic Sequential Control of a 3 Double-acting Cylinder.	14	2	a1, a2, b1, b2, c1, c2, d1, d2.
Number of Weeks /and Units Per Semester		14	28	

VI. Teaching strategies of the course:

- Active Lectures.
- Seminars.
- Laboratory Work.
- Simulation using Computer Software.

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Exercises & Home Works (All the Above Chapters).	a1, a2, b1, b2, c1, c2, d1, d2.	Weekly	10
2	Project (single/group).	a1, a2, b1, b2, c1, c2, d1, d2.	13	5
Total				15

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Exercises & Home Works.	Weekly	15	10 %	a1, a2, b1, b2, c1, c2, d1, d2.
2.	Project (single/group).	13	7.5	5 %	a1, a2, b1, b2,

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					c1, c2, d1, d2.
3.	Quiz 1 and Quiz 2.	8 and 12	7.5	5 %	a1, a2, b1, b2, c1, c2, d1, d2.
4.	Lab. Assessment.	12-14	15	10%	a1, a2, b1, b2, c1, c2, d1, d2.
5.	Mid-term Exam.	9	15	10 %	a1, a2, b1, b2, c1, c2, d1, d2.
6.	Final Exam (theoretical).	16	90	60 %	a1, a2, b1, b2, c1, c2, d1, d2.
Total			150	100%	

IX. Learning Resources:

- Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).

1- Required Textbook(s) (maximum two).

- Anthony Esposito, 2014, "Fluid Power with Applications", Prentice Hall. **1.**
Andrew Parr, 1998, "Hydraulics and Pneumatics", Elsevier (Third Edition). **2.**

2- Essential References.

- 1- Dudleyt, A. Pease and John J. Pippenger, 1987, " Basic Fluid Power ", Prentice Hall.
- 2- Andrew Parr, 1999, " Hydraulics and Pneumatics ", Jaico Publishing House.
- 3- Johnson, James L. Introduction to Fluid Power. ISBN 107668-2365-2.
- 4- Michael J. , Pinches and John G. Ashby, 1989, " Power Hydraulics ", Prentice Hall.

3- Electronic Materials and Web Sites etc.

- Interactive Animation of Hydraulic Systems: http://home.wxs.nl/~brink494/frm_e.htm **1.**
Glossary of Pumps Animation. **2.**
<http://www.animatedsoftware.com/pumpglos/pumpglos.ht>
The Fluid Power Journal: <http://www.fluidpowerjournal.com/>. **3.**

Head of the
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Malik Momin

Quality Assurance
Unit
Assoc. Prof. Dr.
Mohammad
Algorafi

Dean of the
Faculty
Prof. Dr.
Mohammed AL-
Bukhaiti

Academic Development
Center & Quality Assurance
Assoc. Prof. Dr. Huda Al-
Emad

Rector of Sana'a University
Prof. Dr. Al-Qassim
Mohammed Abbas



X.Course Policies:

	Class Attendance:
.1	attendance according to rules and regulations of The students should have more than 75 % of the Faculty.
	Tardy:
.2	The students should respect the timing of attending the lectures. They should attend within 10 minutes from starting of the lecture.
	Exam Attendance/Punctuality:
.3	The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final exam.
	Assignments & Projects:
.4	The assignment is given to the students after each chapter, the student has to submit all the assignments for checking on time.
	Cheating:
.5	If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquiries .
	Plagiarism:
6.	The student will be terminated from the Faculty, if one student attends the exam on another behalf according to the policy, rules and regulations of the university.
	Other Policies:
7.	<ul style="list-style-type: none"> • All the teaching materials should be kept out the examination hall. • The mobile phone is not allowed. • There should be a respect between the student and his teacher.

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