

FLUID POWER AND INDUSTRIAL AUTOMATION**Course Code : 314339**

Programme Name/s : Mechatronics
Programme Code : MK
Semester : Fourth
Course Title : FLUID POWER AND INDUSTRIAL AUTOMATION
Course Code : 314339

I. RATIONALE

The diploma engineer has to use various fluid power operated machines and equipment in different industries. This course will impart knowledge and skills to select appropriate hydraulic and pneumatic system components in the context of industrial automation.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply knowledge and skills of hydraulics and pneumatics system for industrial automation and other applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use fundamentals of fluid power in hydraulic and pneumatic systems.
- CO2 - Select pump/compressor and accessories for given fluid operated system.
- CO3 - Select valves and actuators for given fluid operated system.
- CO4 - Develop various hydraulic / pneumatic circuits for specified application
- CO5 - Construct simple automated hydraulic / pneumatic circuits.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												Total Marks		
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL					
															Practical									
											CL	TL	LL	FA-TH	SA-TH	Total		FA-PR		SA-PR			SLA	
																		Max	Min	Max	Min		Max	Min
314339	FLUID POWER AND INDUSTRIAL AUTOMATION	IAU	DSC	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175			

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 State properties of fluids TLO 1.2 Describe Pascals Law, Continuity equation and Bernoulli's theorem TLO 1.3 Use suitable grade of hydraulic oil for given application TLO 1.4 Classify fluid operated systems	Unit - I Fundamental of fluid power 1.1 Fluid Properties: Density, Viscosity, Specific gravity, Lubricity, Demusibility, Neutralization number, Low foam tendency 1.2 Pascals Law, Continuity equation, Bernoulli's theorem (No numerical) 1.3 ISO grades of hydraulic oil 1.4 Types of fluid operated systems - Oil hydraulic and Pneumatic system, Advantages and limitations and applications and comparison.	Fluid samples for Demonstration Display charts
2	TLO 2.1 Classify hydraulic pump/ Air compressor TLO 2.2 Select the Pump /Compressor relevant for given application. TLO 2.3 State function of Hydraulics/Pneumatics accessories.	Unit - II Pumps, Compressor, Accessories in Hydraulics/ Pneumatics 2.1 Classification of Hydraulic Pumps, Construction and working of Gear pump, Vane pump, Lobe pump and axial piston pump. Selection criterion for pump 2.2 Classification of Compressors, Construction and working of Reciprocating compressor (Single/Multistage), Vane, Screw compressor, Selection criterion for compressor 2.3 Accessories in Hydraulics/Pneumatics: Oil and Air filter, Accumulator, Pressure intensifier, FRL unit, Muffler, pressure gauges, oil reservoir and air receiver	Models/Display charts Animation videos PPT

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	<p>TLO 3.1 Classify control valves</p> <p>TLO 3.2 Describe construction and working of Control valves in Hydraulics/ Pneumatics</p> <p>TLO 3.3 Explain construction and working of actuators in Hydraulics/Pneumatics</p>	<p>Unit - III Control valves and Actuators in Hydraulics/ Pneumatics</p> <p>3.1 Control valves: Classification of control valves, Hydraulic system control valves- Construction and working of - Pressure control valve, Pressure relief valve, Pressure reducing Valve, Sequence Valve, Flow control valve - Fixed and Variable type, Direction control valve- 2/2, 3/2, 4/2, 4/3, 5/2 DCV , Actuating methods- Lever operated, Push button, Solenoid operated.</p> <p>3.2 Pneumatic system control valves - Construction and working of Pilot control valve, Shuttle valve, Twin pressure Valve, Time delay valve.</p> <p>3.3 Hydraulic/Pneumatics Actuators: Construction and working of linear actuator (Single, Double acting cylinder) and rotary actuator (Gear motor, Vane motor, Turbine air motor)</p>	<p>Models/ Display charts</p> <p>Animation videos</p> <p>PPT</p>
4	<p>TLO 4.1 Draw symbols of various components used in hydraulic and pneumatics</p> <p>TLO 4.2 Construct oil hydraulic circuit for given application</p> <p>TLO 4.3 Construct Pneumatic circuit for given application</p> <p>TLO 4.4 List safety precautions in Hydraulic/pneumatics systems</p>	<p>Unit - IV Oil Hydraulic and Pneumatic circuits</p> <p>4.1 ISO symbols for Oil hydraulics and Pneumatics system components</p> <p>4.2 Oil Hydraulic circuits: General layout of Oil Hydraulic system - Actuation of Single acting, Double acting cylinder, Actuation of Unidirectional and Bi-directional Hydro-motor, Speed control (Meter-in, Meter out), Sequencing circuits for simple operations</p> <p>4.3 Pneumatic circuits: General layout of Pneumatic system , Actuation of Single acting, Double acting cylinder, Actuation of Unidirectional and Bi-directional Air -motor, Speed control of Double acting cylinder and bi directional motor, Sequencing circuits for simple operations</p> <p>4.4 Hazards and safety in hydraulic/pneumatics systems</p>	<p>Display chart for ISO symbols</p> <p>Demonstration of trainer/set up</p> <p>Display Charts of fluid power circuits</p> <p>Animation of fluid power circuits</p>
5	<p>TLO 5.1 List function of automation devices</p> <p>TLO 5.2 Explain simple automation circuit using solenoid operated DC valve with diagram.</p> <p>TLO 5.3 Draw impulse or pilot control automation circuits</p> <p>TLO 5.4 Explain automation circuits using special control valves with diagram.</p> <p>TLO 5.5 Describe simple electropneumatic circuits with diagram.</p>	<p>Unit - V Oil Hydraulic and Pneumatic circuits for automation</p> <p>5.1 Devices for automation: Push button switches, Limit switches, Proximity sensors, Solenoid, relays, Timers,</p> <p>5.2 Automation circuit of SAC (Single Acting Cylinder) and DAC (Double Acting Cylinder) using solenoid operated DCV</p> <p>5.3 Automation circuit of SAC and DAC using Single / double pilot operated DCV (impulse operation)</p> <p>5.4 Automation circuits using logic gates valves (Shuttle valve - OR gate, Twin pressure valve- AND Gate), Time delay valve</p> <p>5.5 Basic electropneumatic circuits for SAC and DAC</p>	<p>Display Charts of Automation circuits.</p> <p>Demonstration of trainer/set up</p> <p>Animation of fluid power circuits</p>

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Measure parameters of Total energy (Potential, Kinetic and Pressure energy) LLO 1.2 Calculate parameters of Total energy (Potential, Kinetic and Pressure energy)	1	*Verification of Bernoulli's theorem	2	CO1
LLO 2.1 Identify components of hydraulic and pneumatic system	2	Hydraulic and pneumatic system components.	2	CO1
LLO 3.1 Interpret specifications of pump and compressor mounted on trainer kit. LLO 3.2 Operate pump and compressor to measure pressure and flow rate.	3	*Functional parameters of Oil hydraulic pump and compressor.	2	CO2
LLO 4.1 Identify components of control valves LLO 4.2 Set/Operate Control valves for given application	4	*Pressure relief valve, direction control valve and flow control valve.	2	CO3
LLO 5.1 Identify functional components of actuators. LLO 5.2 Operate and measure speed of actuators	5	*SA, DA cylinders and motors in fluid power system.	2	CO3
LLO 6.1 Identify components of Shuttle valve, Twin pressure valve. LLO 6.2 Set/Operate Shuttle valve, Twin pressure valve.	6	Shuttle valve, Twin pressure valve used in pneumatic system.	2	CO3
LLO 7.1 Select components for given speed control circuit LLO 7.2 Construct hydraulic circuit LLO 7.3 Test speed variation of an actuators	7	Hydraulic circuit for SAC and DAC, Hydro-motor.	2	CO4
LLO 8.1 Select components for given speed control circuit. LLO 8.2 Construct and actuate hydraulic speed control circuit.	8	*Speed control circuits: Meter-in and Meter out hydraulic circuit.	2	CO4
LLO 9.1 Select components for given circuit. LLO 9.2 Construct pneumatic circuit. LLO 9.3 Operate given actuators	9	*Pneumatic circuits for SAC and DAC, Air motor.	2	CO4
LLO 10.1 Select components for given speed control circuit LLO 10.2 Construct and actuate pneumatic speed control circuit	10	Speed control circuits for pneumatic system	2	CO3 CO4
LLO 11.1 Select components for given sequencing hydraulic circuit. LLO 11.2 Connect and test given sequencing hydraulic circuit.	11	Sequencing hydraulic circuit.	2	CO3 CO4

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 12.1 Select components for given sequencing pneumatic circuit. LLO 12.2 Connect given sequencing pneumatic circuit LLO 12.3 Test the sequencing circuit.	12	*Sequencing pneumatic circuit.	2	CO3 CO4
LLO 13.1 Select components for given Automation circuit. LLO 13.2 Construct and actuate given automation circuit.	13	Automation circuit for SAC and DAC using solenoid operated DCV	2	CO3 CO5
LLO 14.1 Select components for given impulse automation circuit LLO 14.2 Connect and test given impulse automation circuit.	14	Impulse automation circuit for SAC and DAC using Single / double pilot operated DCV(use trainer or Fluid SIM free software)	2	CO3 CO5
LLO 15.1 Select components for given automation circuit. LLO 15.2 Connect and test given automation circuit.	15	*Automation circuits using logic gates valves (OR/AND gate) (use trainer or Fluid SIM free software)	2	CO3 CO5
LLO 16.1 Select components for given circuit. LLO 16.2 Connect pneumatic circuit. LLO 16.3 Test given circuit.	16	Electro-pneumatic circuits for SAC and DAC	2	CO3 CO5
Note : Out of above suggestive LLOs - <ul style="list-style-type: none"> • '*' Marked Practicals (LLOs) Are mandatory. • Minimum 80% of above list of lab experiment are to be performed. • Judicial mix of LLOs are to be performed to achieve desired outcomes. 				

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)**Assignment**

- Collect information of applications of hydraulic system in universal testing machine with the help of Laboratory visit - study of type of pump used, oil pressure, type of actuator used, auto cut off mechanism after specimen test.
- Prepare report of Market Survey of various grades of hydraulic oil. - manufacturer, specify viscosity, working temperature range, cost/liter, packaging type and capacity
- Prepare display chart for different hydraulic and pneumatic equipment used at service station (Type of equipment, Function and photograph of actual use)
- Prepare PPT on application of Hydraulic equipment used at construction site. Student may visit nearby site to collect information related to type, function, images of actual operations,etc
- Prepare a display chart of different ISO symbols of hydraulic/pneumatic components. (Use colour sketch pens and drawing sheet)

Micro project

- Prepare report on different actuators for mechatronic applications as per following parameters. - stroke length, bore, diameter of cylinder, working pressure, Bursting pressure, torque, speed, types of mountings using internet

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- Prepare report on specification of hydraulic pumps using internet by visiting website of suppliers. Prepare a table with following specification: make/ manufacturer, Pressure range, Type of pump, type of prime mover required, compatibility with different grades of oil.
- Prepare working models of any hydraulic system using disposable syringe. e.g. Robot arm movement
- Prepare a display chart on different types of actuators used for earthmoving equipment like tractor trolley, JCB, Crane (Type of Actuator, Function and photograph of actual use)
- Prepare a model of any type of pump size 60 cm X 60 cm using card board. Use various colours to show casing ports and constructional elements.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Bernoulli's theorem apparatus With Pipe of varying cross sectional area, Pump of Max Head 21 Meter, Water flow 1.35 Lit/Sec, Motor rating -0.37KW, Sump Tank Capacity:250 Liter	1
2	Festo Fluid SIM free software/ any other suitable software	14,15
3	Limit switches (Operating pressure range : 3 to 70 kgf/cm ² , Operating speed range : 8 -100mm/sec, Operating temperature range : -10 to 80 Deg.Celsius), Solenoid operated valves (12/24VDC), proximity switches (range of 0 - 40 mm), roller operated valves (maximum working pressure 210 bar, Flowrate 60 l/min)	15,16
4	Charts, cut section models, actual samples of different components of fluid power system	2,3,4
5	Hydraulic Trainer kit with various components like Hydraulic power pack, Set of Pressure relief, Pressure reducing and Sequence valve, 3/2, 4/2,4/3 DCV, Flow control valve with built in check valve, pipes and hoses, SA Cylinder, DA Cylinder	2,3,4,7,8,11,13
6	Pneumatic trainer kit with portable compressor pressure up to 12 Bar, FRL Unit, 3/2, 5/2,5/3 DCV, Solenoid operated valves, Flow control valve with check valve, Twin pressure valve, Shuttle valve, pipes and low pressure hoses, SA Cylinder, DA Cylinder	5,6,9,10,12,14,15

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamental of fluid power	CO1	5	2	4	2	8
2	II	Pumps, Compressor, Accessories in Hydraulics/ Pneumatics	CO2	10	2	8	4	14

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Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
3	III	Control valves and Actuators in Hydraulics/ Pneumatics	CO3	10	4	4	8	16
4	IV	Oil Hydraulic and Pneumatic circuits	CO4	10	4	4	8	16
5	V	Oil Hydraulic and Pneumatic circuits for automation	CO5	10	2	4	10	16
Grand Total				45	14	24	32	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Two-unit tests of 30 marks and average of two-unit tests. · For laboratory learning term work -25 Marks · For Self Learning 25 Marks

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	-	2	2	2	3			
CO2	3	-	-	2	-	2	2			
CO3	3	-	-	2	-	2	2			
CO4	3	-	2	2	3	2	3			
CO5	3	-	2	3	3	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
 *PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dr. P. N. Modi, Dr. S. M. Seth	Hydraulics and Fluid mechanics including hydraulics machines	Standard Book House, Rajsons Publication Pvt. Ltd., New Delhi, ISBN 978-81-89401-26-9, Year: 2017
2	C. P. Kothandaraman, R. Rudramoorthy	Fluid Mechanics and Machinery	New Age International (P) Limited, New Delhi, ISBN : 978-81-224-3398-2, Year : 2012

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Sr.No	Author	Title	Publisher with ISBN Number
3	Majumdar S.R.	Oil Hydraulic system- Principles and maintenance	Tata McGraw Hill, ISBN: 978-0-07-463748-7, Year : 2013
4	Majumdar S.R.	Pneumatics Systems Principles and Maintenance	Tata McGraw Hill, ISBN: 978-0-07-463748-7, Year : 2013
5	Shanmuga Sundaram	Hydraulic and Pneumatic Controls	S. Chand Publishing, New Delhi, ISBN: 978-8-12-192635-5, Year:2013
6	Andrew Parr	Hydraulics & Pneumatics A Technicians & Engineers Guide	Butterworth-Heinemann Publisher, New Delhi ISBN: 978-0-08-096675-5, Year: 2006

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://en.wikipedia.org/wiki/Hydraulic_pump	Hydraulic Pumps (all types)
2	https://www.youtube.com/watch?v=Qy1iV6EzNHg	Animation of Hydraulic pumps (all types)
3	https://www.youtube.com/watch?v=pWuxYnqYDnk	Animation of Hydraulic pumps
4	https://www.youtube.com/watch?v=sEVTIRYHoGg	Eaton Pump assembly
5	https://www.youtube.com/watch?v=XAItnsUcES0	Pneumatic control valves animation
6	https://www.youtube.com/watch?v=yIot4shcOkE	Control valve symbol generation
7	https://www.youtube.com/watch?v=jsMJbJQkGTs	Animation of D.C. Valve
8	https://www.youtube.com/watch?v=CQPwvWXbV3w	Animation of 4/2,4/3 D.C Valves
9	https://www.youtube.com/watch?v=bovfDsAYSbc	Animation of Hydraulic cylinder
10	https://www.youtube.com/watch?v=icaqvAtccY	Telescopic cylinder animation
11	https://www.youtube.com/watch?v=MmYpzh6Gok	Pneumatic cylinder
12	https://www.youtube.com/watch?v=WRCj5Tnopo0	Pilot control pneumatic circuits
13	https://www.youtube.com/watch?v=4eCuPVxezzY	Speed control hydraulic circuit
14	https://www.youtube.com/watch?v=2HNkIldunyY	Material Handling Automated System
15	https://www.youtube.com/watch?v=355XnDsAkDw	Pneumatic components automation line
16	https://www.youtube.com/watch?v=PvYu200BVy4	Introduction to Festo FluidSIM 6

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students