GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL (CAD/CAM) (08) AND MECHANICAL (MACHINE DESIGN) (09)

OIL HYDRAULICS AND PNEUMATICS

SUBJECT CODE: 2730807

M.E. SEM-III

Type of course: Post Graduate

Prerequisite: None

Rationale: A revolutionary change has taken place in the field of Fluid Power Technology. An engineer in the field of design may require knowledge of power transmission; or in the field of operation and maintenance needs to know the power transmission system of machine tools, presses, equipment. An engineer should be well acquainted with various selection and manufacturing techniques, control, procedure and application of hydraulic/pneumatic components.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks		Practical Marks				
L	T	P	C	ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction:** Functional requirements of a power transmission, how these requirements can be fulfilled by various power transmission systems like mechanical, oil hydraulic, pneumatic, electrical or their combinations; Fundamentals of oil hydraulics and pneumatics, Control functions of oil hydraulic systems; Comparison between Mechanical, Oil Hydraulic, Pneumatic and Electrical power transmission systems; Advantages, disadvantages and Applications of Oil Hydraulic and Pneumatic power transmissions.	**3**	10%
2	**System Components:** Hydraulic & Pneumatic Symbols as per ISO/ANSI, Properties and selection of hydraulic fluids, Filtration, Hydraulic Reservoirs and Accumulators, Intensifiers or Pressure Boosters, Seals and Packing.	**4**	5%
3	**Oil Hydraulic Pumps and Actuators:** Construction, working principle and operation of rotary & reciprocating pumps like Gear, Vane, Generated-Rotor, Screw, Axial Piston, Radial Piston, Pump characteristics, Specifications and selection of pumps; Linear actuators like Ram type, Telescopic and Single acting/double acting, types of their constructions, types of mountings, cylinder materials, cushioning of hydraulic	**6**	15%

	cylinders, Rotary actuators, specifications, sizing and selection of pumps and actuators.		
4	**Control Valves:** Construction, working principle and operation of Direction control valves, Flow control valves and Pressure control valves; including Check, Pressure relief, Compound Pilot operated Pressure Relief, Safety, Sequence, Pressure Reducing, Unloading, Counterbalance valves. Different types of center positions of DCVs, Methods of actuation of DCVs.	**8**	10%
5	**Hydraulic and Pneumatic Controllers used in Feedback Control systems:** Construction, working principle and operation of Proportional and Servo control valves including Servo-type DCV like nozzle valve, flapper type valve, mechanical servo valve, single and double stage servo valves; Applications of servomotor systems in feedback control systems.	**4**	10%
6	**Hydraulic Circuits:** Reciprocation, quick return, sequencing, flow control circuits, synchronizing circuits, accumulator circuits, industrial circuits like press circuits, machine tool circuits, forklift, earth mover circuits- design and selection of components.	**4**	15%
7	**Pneumatic Systems and Circuits:** Pneumatic fundamentals, Construction, working principle and operation of pneumatic power transmission system components like Power source, FRL unit, Actuators and control valves like DCV, FCV, PCV, time delay, quick exhaust, twin pressure, shuttle; Pneumatic circuits like reciprocating circuits, switching circuits, sequential circuits, hydro pneumatic circuits, solenoid operated circuits, simple logic circuits, Programmable logic circuits using PLC/Microcontroller and their applications; selection, sizing and specifications of pneumatic components.	**12**	35%

Reference Books:

1. Industrial Hydraulics by John Pippenger and Tyler Hicks, McGraw Hill.
2. Oil Hydraulic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.
3. Fluid Power with Applications by Anthony Esposito, Pearson.
4. Fluid Power: Generation, Transmission and Control, Jagadeesha T., Thammaiah Gowda, Wiley.
5. The Analysis & Design of Pneumatic Systems by B. W. Anderson, John Wiley.
6. Control of Fluid Power Analysis and Design by Mc Clay Donaldson, Ellis Horwood Ltd.
7. Hydraulic and Pneumatic Controls: Understanding made Easy, K.Shanmuga Sundaram, S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)
8. Basic Pneumatic Systems, Principle and Maintenance by S R Majumdar**,** McGraw-Hill.
9. Basic fluid power Dudley, A. Pease and John J. Pippenger, , Prentice Hall, 1987

Course Outcome:

After learning the course the students should be able to:

1. Identify and analyze the functional requirements of a power transmission system for a given application. (Application involving fluid power transmission)
2. Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application. Develop a circuit diagram.
3. Visualize how the hydraulic/pneumatic circuit will work to accomplish the function.

4. Selection and sizing of components of the circuit.

List of Experiments:

A. Experiments on Hydraulics: Circuits:
    1) Extend-Retract and Stop system of a linear actuator and Actuation of a rotary actuator.
    2) Regenerative circuit.
    3) Speed Control circuits: meter-in, meter-out and bleed off.
    4) Sequencing circuit
    5) Use of solenoid operated DCV.
    6) Rapid Traverse and Feed circuit.
B. Experiments on Pneumatic Circuits:
    1) Study of Compressor, FRL unit and 5/3 DCV.
    2) Reciprocating motion of a single and a double acting actuators using 5/3 DCV & Pilot operated DCV.
    3) Speed control circuits.
    4) Automatic to & fro motion of a pneumatic linear actuator.
    5) Sequencing circuit
    6) Time delay circuit
    7) Logical circuits using shuttle valve and twin pressure valve
C. Students should build up the above circuits on computer using software like Automation Studio and simulate the flow of fluid during the operation, should learn and check the forward and return path. Afterwards, they themselves can physically connect the connections to build up a circuit on the hydraulic/pneumatic trainer and run the circuit.

Design based Problems (DP)/Open Ended Problem:
Student should be given an application of a power transmission system for which he will evaluate the functional requirements of power transmission and design appropriate circuit with due justification. He has to select and size the components, and specify the components. He should explain the working of circuit (preferably with the help of software like Automation Studio, Festo FluidSIM) through a presentation. The application must involve use of hydraulics/pneumatics and/or combinations of different power transmission systems.

Major Equipment:

1. A hydraulic trainer.
2. A pneumatic trainer.
3. Software like Automation Studio, where the simulation can be visualized.

List of Open Source Software/learning website:

1) Autosim Premium
2) Hydrosym
3) Scilab

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.