INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS**			
Course Code	BC004			
Course Structure	Lectures	Tutorials	Practicals	Credits
	3	-	-	3
Course Coordinator	M. Vijay Kumar, Asst.Professor			
Team of Instructors	-			

I. COURSE OVERVIEW

This course provides students with an introduction to principal concepts and methods of fluid mechanics. Topics covered in the course include pressure, hydrostatics, and buoyancy; open systems and control volume analysis; mass conservation and momentum conservation for moving fluids; viscous fluid flows, flow through pipes; dimensional analysis; boundary layers, and lift and drag on objects. Students will work to formulate the models necessary to study, analyze, and design fluid systems through the application of these concepts, and to develop the problem-solving skills essential to good engineering practice of fluid mechanics in practical applications

II. PREREQUISITE(S)

Level	Credits	Periods/ Week	Prerequisites
UG	3	3	Fluid mechanics and Hydraulic Machines

III. MARKS DISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS	70 Marks	30 Marks	100 Marks

Semester End Examination 70 Marks All the Units (1, 2, 3, 4 and 5)	70 Marks (3 Hours)	5 questions to be answered. Each question carries 14 Marks

<table>
<tr><td rowspan="6">Average of two CIA Examinations</td><td colspan="4">Continuous Internal Assessment (CIA) - 1</td></tr>
<tr><td rowspan="3">30 Marks
(2 Hours)</td><td rowspan="3">Units
I, II and
III (half)</td><td rowspan="2">Continuous Internal Examination (CIE)
(2 hours)
[4 questions to be answered out of 5 questions from Part- A & B]</td><td>Part - A
5 questions to be answered out of 5 questions, each carries 1 mark.</td></tr>
<tr><td>Part - B
4 questions each carry 5 marks.</td></tr>
<tr><td>Technical Seminar and Term Paper</td><td>5 marks</td></tr>
<tr><td colspan="4">Continuous Internal Assessment (CIA) - 2</td></tr>
<tr><td rowspan="3">30 Marks
(2 Hours)</td><td rowspan="3">Units
III (half)
IV and V</td><td rowspan="2">Continuous Internal Examination (CIE)
(2 hours)
[4 questions to be answered out of 5 questions from Part- A & B]</td><td>Part – A
5 questions to be answered out of 5 questions, each</td></tr>
<tr><td>Part - B
4 questions each carry 5 marks.</td></tr>
<tr><td>Technical Seminar and Term Paper</td><td>5 marks</td></tr>
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IV. EVALUATION SCHEME

S. No	Component	Duration	Marks
1	CIE - I Examination	2 hour	25
2	Technical Seminar and Term Paper	10 minutes seminar and 1000 words document	05
TOTAL			30
3	CIE - II Examination	2 hour	25
4	Technical Seminar and Term Paper	10 minutes seminar and 1000 words document	05
TOTAL			30
CIA Examination marks to be considered as average of above two CIA's			
5	EXTERNAL Examination	3 hours	70
GRAND TOTAL			100

V. COURSE OBJECTIVES

The course should enable the students to

I. Understand and study the effect of fluid properties on a flow system
II. Apply the concept of fluid pressure, its measurements and applications.

III. Explore the static, kinematic and dynamic behaviour of fluids.
IV. Assess the fluid flow and flow parameters using measuring devices.

VI. COURSE OUTCOMES

At the end of the course the students are able to:

I. **Identify:** the functional requirements of fluid dyamics.
II. **Problem analysis**: Identify, formulate, review research literature
III. **Design/development of solutions**: Design solutions for complex engineering problems
IV. **The engineer and society**: Apply reasoning informed by the contextual knowledge

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program Outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	H	Seminar
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	H	Seminar
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	H	Projects
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	S	Projects
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	S	Projects
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.		--
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development		--
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.		--
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.		--
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.		--

PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments		--
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.		Projects

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical system including allied engineering streams.	H	Lectures, Seminars
PSO 2	**BROADNESS AND DIVERSITY:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	S	Projects
PSO 3	**Successful Career and Entrepreneurship:** To build the nation by imparting technological inputs and managerial skills to become a Technocrats.	S	Guest Lectures

N - None **S - Supportive** **H - Highly related**

IX. SYLLABUS

UNIT-I	OIL AND HYDRAULIC SYSTEMS
Introduction, history of fluid power, Pascal‟s law, Bramah‟s Press, Bernoulli‟s principle, Toricelli principle, fluid principle, fluid properties, viscosity, effect of temperature, dust and decay of oils, basic systems of hydraulic, physical units of fluid power, units of measurement, types of hydraulic fluid and selection criteria, properties of hydraulic fluid, physical characteristic, maintenance of hydraulic oils, oil hydraulic element and their representation in the circuits, comparison of mechanical, electrical, hydraulic and pneumatic systems for force and motion, analysis in automation.	
UNIT-II	**HYDRAULIC PUMPS**
Classification of pumps, gear pump, types of gear pumps, screw pump, vane pump, types of vane pumps, piston pump, bent axis in line piston pump, internal and external gear pumps, selection and sizing specification of pumps, specification of pumps, pump and pressure pulsation, flow rate and power of hydraulic pump, power and pump efficiencies, pressure, flow efficiencies, oil compatibility, size, noise, pump ripple, checklist; Actuators, design of linear actuator, cushioning, seals, mounting details, piston rod diameter and its effect on the pressure, servo controlled valves, hydraulic balanced circuits, sequencing and synchronizing circuits, rotary actuators.	
UNIT-III	**HYDRAULIC POWER PACK**
Element of power pack, design of hydraulic power pack, line pressure, discharge and motor. Selection, power pack size and capacity, importance of pressure relief valve and safety systems, heating and cooling systems for hydraulic power pack.	
UNIT-IV	**HYDRAULIC CIRCUITS AND ACCUMULATOR**
Hydaulic circuits, manual or automatic hydraulic system, regenerative circuit, use of check valves in hydraulic circuit, selection of pump, standard in circuit circuit diagram representation, sequencing and synchronizing circuits; accumulator, low cost automation; meter-in circuit, meter-out circuit, bleed-off circuit, direction control valves, solenoid valves, flow control and pressure control valves, pressure compensation, accumulator.	
UNIT-V	**AUTOMATION**
Hydraulic and pneumatic equipment in automation, low cost automation, relay circuit, programmable logic circuit, automation, micro controller; maintenance and troubleshooting of hydraulic and pneumatic circuit.	

Text Books:
1. S. R. Majumdar, “Oil Hydraulic Systems”, Tata McGraw Hill, 1st Edition, 2013. 2. S. R. Majumdar, “Pneumatic Systems, Principles &maintaianance”, Tata McGraw Hill, 1st Edition, 2013.
Reference Books:
1. Andrew Parr, “Hydraulic & Pneumatic”, Butterworth-Heinemann Ltd, 2nd Edition, 2013. 2. Antony Esponssito, “Fluid Power with applications”, Prentice Hall, 5th Edition, 2015.

COURSE PLAN

At the end of the course, the students are able to achieve the following course learning outcomes.

Lecture No.	Course learning outcomes	Topics to be covered	Referene
1	Outline of various units	UNIT – I Introduction,	**T1,T2**
2	Explain fluid power	history of fluid power	**T1**
3	Determine laws	Pascal‟s law, Bramah‟s Press,	**T1**
4-5	Understand the principles	Toricelli principle, fluid principle, fluid properties,	**T1**
6-7	Understand the effect of temperature effects	viscosity, effect of temperature, dust and decay of oils	**T1,T2**
8-9	Understand about hydraulic systems	basic systems of hydraulic, physical units of fluid power, units of measurement,	**T1**
10-11	Understand the properties of hydraulic fluid	types of hydraulic fluid and selection criteria, properties of hydraulic fluid, physical characteristic	**T1**
12-13	Understand the maintenance of oils	maintenance of hydraulic oils, oil hydraulic element and their representation in the circuits,	**T1**
13-15	Discuss about different systems	Comparison of mechanical, electrical, hydraulic and pneumatic systems for force and motion, analysis in automation.	**T1,T2**
16-19	Define pump and its types	UNIT-II Classification of pumps, gear pump, types of gear pumps, screw pump, vane pump, types of vane pumps,	**T1**
20-22	Explain the sizing of pump	piston pump, bent axis in line piston pump, internal and external gear pumps, selection and sizing specification of pumps,	**T1**
23-25	Understand the flow rate of pumps and efficiency	pump and pressure pulsation, flow rate and power of hydraulic pump, power and pump efficiencies, pressure, flow efficiencies, oil compatibility,	**T1**
26-28	Discuss about actuators and effect of pressure	size, noise, pump ripple, checklist; Actuators, design of linear actuator, cushioning, seals, mounting details, piston rod diameter and its effect on the pressure, servo controlled valves, hydraulic balanced circuits, sequencing and synchronizing circuits, rotary actuators.	**T1,T2**
29-30	Define elements of power pack systems	UNIT-III Element of power pack, design of hydraulic power pack, line pressure,	**T1**

		discharge and motor.	
31-33	Discuss about the capacity of hydraulic systems	Selection, power pack size and capacity, importance of pressure relief valve and safety systems, heating and cooling systems for hydraulic power pack	**T1,R1**
34-36	Define hydraulic circuits and valves	UNIT-IV Hydraulic circuits, manual or automatic hydraulic system, regenerative circuit, use of check valves in hydraulic circuit,	**T2**
37-40	Understand the selection of pump	selection of pump, standard in circuit, circuit diagram representation, sequencing and synchronizing circuits;	**T1,T2**
41-43	Explain about different circuits	accumulator, low cost automation; meter-in circuit, meter-out circuit, bleed-off circuit,	**T1**
44-46	Discuss the control valves in systems	direction control valves, solenoid valves, flow control and pressure control valves,	**T1**
47-52	Explain about accumulator	Pressure compensation, accumulator.	**T1**
53-57	Understand the hydraulic and pneumatic equipment in detailed	UNIT-V Hydraulic and pneumatic equipment in automation,	**T1,T2**
58-62	Understand the cost automation	low cost automation, relay circuit,	**T1,R1**
63-66	Understand the programmable logic circuits and controllers	programmable logic circuit, automation, micro controller	**T1**
67-70	Discuss the maintenance and troubleshooting of hydraulic systems	Maintenance and troubleshooting of hydraulic and pneumatic circuit.	**T1,R1**

XI MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
I	H	H										S	H	H	
II		H	S		S								S	H	
III	S	H	S										H		S
IV	H	S											H	S	
V	H	S											H	S	S

S - Supportive H - Highly related

XII MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES ANDPROGRAM SPECIFIC OUTCOMES

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	H			S									H	S	
2	S	H	S									S	H		S
3	S	H			S								S		
4	H			S								S	S	S	
5	S	H	S		S							S	H		S
6	H	S		S									S		
7	H				S							S	H	S	
8	H			S									H	S	
9	S	H	S									S	H		S

S - Supportive H - Highly related

Prepared by: M. Vijay Kumar, Assistant Professor

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