SCHEME OF EVALUATION

(Scoring Indicators)

Revision : 2015 Course Code : 3022

Course Title : Fluid Mechanics & Pneumatics

Qn NO	Scoring indicator	Split up score	Sub Total	Total
I	**PART A**			
1	A fluid is a substance that deforms continuously when subjected to a tangential or shear stress, however small the shear may be.	1x2	2	10
2	Reynold's Number is defined as ratio of inertia forces to viscous forces to fluid. It is a non dimesional number. It's symbol is Re.	1x2	2	
3	Fluid power is the technology that deals with the generation, control and transmission of forces and movement of mechanical element or system with the use of pressurized fluids in a confined system.	1x2	2	
4	Air fliters, compressor, Air cooler, Dryer, Control valves and Air acutator (any four full marks)	0.5x4	2	
5	The ratio of the density/weight density of the fluid to the density/ weight density of standard fluid is called as Specific gravity or Relative density.	1x2	2	
II	**PART B**			
1	Gauge Pressure(Pg) : If the pressure of fluid measured with the help of a measuring instrument either above or below atmospheric pressure is called gauge pressure.(positive value means above Patm and negative value means below Patm) Vacuum Pressure (Pv) : If the pressure of fluid below the atmospheric pressure, it is called vacuum pressure. Absolute Pressure (Pabs) : When the pressure is measured above the absolute zero pressure it is called Absolute pressure. It can never be negative. For Positive pressure gauge reading : Pabs = Patm + Pg For Negative pressure gauge reading : Pabs = Patm - Pv	2x3	6	
2	$Q_{ac} = \frac{c_d * 8 * tan\left(\frac{\theta}{2}\right)\sqrt{2g} * H\text{^}(\frac{5}{2})}{15}$ H = 0.45 m , Cd = 0.63 , θ = 60 substituting in above equation we get discharge = 64.70 lit/sec	Equation 2 mark + 4 mark answer	6	30
3	Demulsibility : It is capability of a hydraulic fluid to separate or reject water. It means separation from oil. Highly refined mineral oils permit water to separate or demulsify readily. Viscosity Index : Viscosity index is an empirical number indicating the rate of change in viscosity of an oil with in a given temperature range. A low viscosity index signifies a relatively large change in viscosity with temperature, where as a high viscosity index shows relatively small change in viscosity with temperature.	3x2	6	

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VI a.	Dia. of pipe, $d = 200$ mm $= 0.20$ m Length of pipe, $L = 500$ m Difference of pressure head, $h_f = 4$ m of water $f = .009$ Using equation (11.1), we have $h_f = \frac{4 \times f \times L \times V^2}{d \times 2g}$ $4.0 = \frac{4 \times .009 \times 500 \times V^2}{0.2 \times 2 \times 9.81}$ or $V^2 = \frac{4.0 \times 0.2 \times 2 \times 9.81}{4.0 \times .009 \times 500} = 0.872$ $\therefore \quad V = \sqrt{0.872} = 0.9338 \simeq 0.934$ m/s $\therefore$ Discharge, Q = velocity × area $= 0.934 \times \frac{\pi}{4} d^2 = 0.934 \times \frac{\pi}{4} (0.2)^2$ $= 0.0293$ m^3/s = **29.3 litres/s. Ans.**	Equation 2 + 2x2 mark answer	6	
VI b.	Dia. at inlet, $d_1 = 30$ cm $\therefore \quad a_1 = \frac{\pi}{4} (30)^2 = 706.85$ cm^2 Dia. at throat, $d_2 = 15$ cm $\therefore \quad a_2 = \frac{\pi}{4} (15)^2 = 176.7$ cm^2 $h = x \left[\frac{S_h}{S_o} - 1 \right] = 20 \left[\frac{13.6}{1.0} - 1.0 \right] = 20 \times 12.6 = 252.0$ cm of water $C_d = 0.98$ Discharge, $Q = C_d \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$ $= 0.98 \times \frac{706.85 \times 176.7}{\sqrt{(706.85)^2 - (176.7)^2}} \times \sqrt{2 \times 981 \times 252}$ $= \frac{86067593.36}{\sqrt{499636.3 - 31222.9}} = \frac{86067593.36}{684.4}$ $= 125756$ cm^3/s = **125.756 lit/s. Ans.**	Equation 4 + 5 mark answer	9	15

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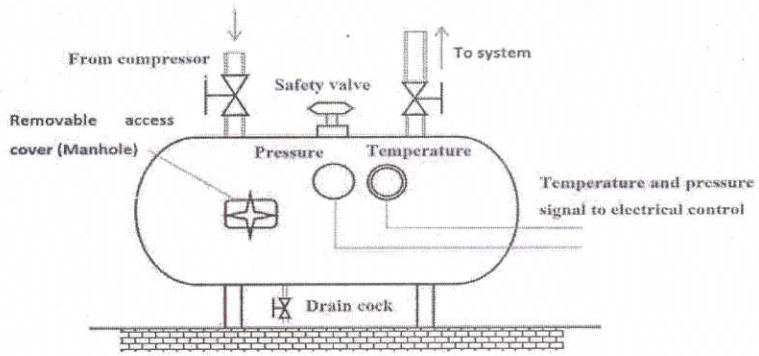
4	 Receivers perform several functions in compressed air systems. Firstly, they provide a larger system capacity, which increases the cycle time of compressor control systems. This makes less difficult the elimination of unstable and overcorrecting control cycles. The receiver also dampens pulsations from reciprocating compressors, acts as a reservoir to prevent excessively temporary pressure drop during sudden short-term demand, and can be used to smooth air flow through dryers, separators and other air conditioning equipment. As the air entering the receiver is reduced in velocity and cooled, some of the moisture may condensate and fall to the bottom of the receiver where it can be removed by a valve or preferably, a trap. Such a receiver can reduce further the amount of moisture which must be removed by a subsequent drying stage. The receiver always equipped with a pressure relief valve.	Fig 4 + Exp 2	6	
5	The fluids are classified as follows : Ideal Fluids : Ideal fluids are those fluids which have no viscosity and surface tension and they are incompressible. However in nature the ideal fluids do not exist and these are only imaginary fluids Real Fluids : Real fluids are those fluids which are actually available in nature. These fluids have the properties such as viscosity, surface tension and compressibility. All fluids in actual practice are real fluids Newtonian Fluids : A real fluid in which shear stress is directly proportional to the rate of shear strain Non-Newtonian Fluids : A real fluid in which shear stress is not proportional to the rate of shear strain Ideal Plastic Fluid : A fluid in which shear stress is more than the yield value and shear stress is proportional to the rate of shear strain.	5x1.2	6.	

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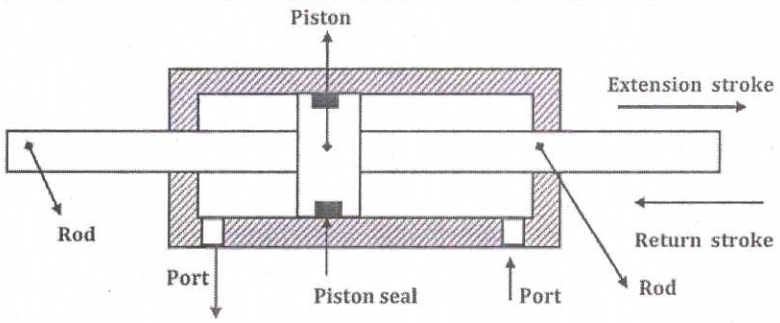
6	1.Automobiles :Power steering, power brakes, suspension systems, hydrostatic transmission. 2.Automation : Automated transfer lines, robotics 3.Construction industry/equipment : For metering and mixing of concrete rudders, excavators, lifts, bucket loaders, crawlers, post-hole diggers, road graders, road cleaners, road maintenance vehicles, tippers. 4.Defense : Missile-launching systems, navigation controls 5.Entertainment : Amusement park entertainment rides such as roller coasters 6.Fabrication industry : Hand tools such as pneumatic drills, grinders, borers, riveting machines, nut runners 7.Food and beverage : All types of food processing equipment, wrapping, bottling 8.Jigs and fixtures : Work holding devices, clamps, stoppers, indexers 9.Machine tools : Automated machine tools, numerically controlled(NC) machine tools 10.Materials handling : Jacks, hoists, cranes, forklifts, conveyor systems 11.Mining : Rock drills, excavating equipment, ore conveyors, loaders 12.Paper and packaging : Process control systems, special-purpose machines for rolling and packing 13.Plastic industry : Automatic injection molding machines, raw material feeding, jaw closing, movement of slides of blow molder 14.Press tools : Heavy duty presses for bulk metal formation such as sheet metal, forging, bending, punching, etc. 15.Transportation : Hydraulic elevators, winches, overhead trams	1X6	1X6	
7	 **Figure 1.5**Double-acting cylinder with a piston rod on one side A double-acting cylinder with a piston rod on both sides (Fig.1.5)is a cylinder with a rod extending from both ends. This cylinder can be used in an application where work can be done by both ends of the cylinder, thereby making the cylinder more productive. Double-rod cylinders can withstand higher side loads because they have an extra bearing, one on each rod, to withstand the loading. This arrangement allows equal force and speed in both directions. These are also called as non-differential cylinders because the area that fluid pushes on is the same on each side of the piston.	Fig 4 + Exp 2	1X6	

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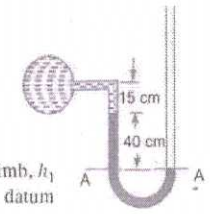
	PART C			
III a.	$\rho = m/V = 1200/0.952 = 1261\ \text{kg/m}^3$ $\gamma = W/V = 11.77/0.952 = 12.36\ \text{kN/m}^3$ $\text{s.g.} = \gamma_{\text{glyc}}/\gamma_{H_2O \text{ at } 4\,^\circ\text{C}} = 12.36/9.81 = 1.26$	3X3	9	
III b.	Depth of liquid, $Z_1 = 3$ m Density of liquid, $\rho_1 = 1.53 \times 10^3$ kg/m^3 Atmospheric pressure head, $Z_0 = 750$ mm of Hg $= \frac{750}{1000} = 0.75$ m of Hg $\therefore$ Atmospheric pressure, $p_{atm} = \rho_0 \times g \times Z_0$ where ρ_0 = Density of Hg = Sp. gr. of mercury × Density of water = 13.6×1000 kg/m^3 and Z_0 = Pressure head in terms of mercury. $\therefore$ $p_{atm} = (13.6 \times 1000) \times 9.81 \times 0.75$ N/m^2 ($\because$ $Z_0 = 0.75$) $= 100062$ N/m^2 Pressure at a point, which is at a depth of 3 m from the free surface of the liquid is given by, $p = \rho_1 \times g \times Z_1$ $= (1.53 \times 1000) \times 9.81 \times 3 = 45028$ N/m^2 $\therefore$ Gauge pressure, $p = \mathbf{45028\ N/m^2}$. Ans. Now absolute pressure = Gauge pressure + Atmospheric pressure $= 45028 + 100062 = \mathbf{145090\ N/m^2}$. Ans.	3X2	6	15
IV a.	**Solution.** Given : Sp. gr. of fluid, $S_1 = 0.8$ Sp. gr. of mercury, $S_2 = 13.6$ Density of fluid, $\rho_1 = 800$ Density of mercury, $\rho_2 = 13.6 \times 1000$ Difference of mercury level, $h_2 = 40$ cm = 0.4 m. Height of liquid in left limb, $h_1 = 15$ cm = 0.15 m. Let the pressure in pipe = p. Equating pressure above datum line A-A, we get $\rho_2 g h_2 + \rho_1 g h_1 + p = 0$ $p = -[\rho_2 g h_2 + \rho_1 g h_1]$ $= -[13.6 \times 1000 \times 9.81 \times 0.4 + 800 \times 9.81 \times 0.15]$ $= -[53366.4 + 1177.2] = -54543.6$ N/m^2 = **– 5.454 N/cm^2**. Ans.  Fig. 2.11	Equation 3 + 5 mark answer	8	

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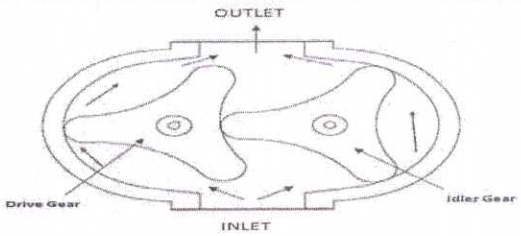
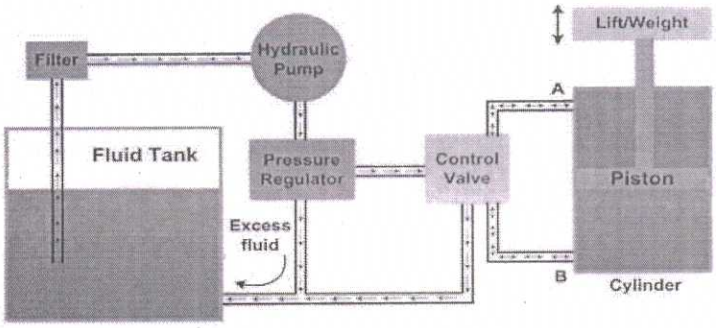
VII b.	 The operation of lobe pump is similar to that of external gear pump, but they generally have a higher volumetric capacity per revolution. The output may be slightly greater pulsation because of the smaller number of meshing elements. Lobe pumps, unlike external gear pumps, have both elements externally driven and neither element has any contact with the other. For this reason, they are quieter when compared to other types of gear pumps. Lobe contact is prevented by external timing gears located in the gearbox. Pump shaft support bearings are located in the gearbox, and because the bearings are out of the pumped liquid, pressure is limited by bearing location and shaft deflection. They do not lose efficiency with use. They are similar to external gear pumps with respect to the feature of reversibility.	Fig 3 + Exp 3	6	15

Qn NO	Scoring indicator	Split up score	Sub Total	Total
VII a.	 Figure 5.1.2 Schematic of hydraulic system The storage/fluid tank is a reservoir for the liquid used as a transmission media. The liquid used is generally high density incompressible oil. It is filtered to remove dust or any other unwanted particles and then pumped by the hydraulic pump. The capacity of pump depends on the hydraulic system design. These pumps generally deliver constant volume in each revolution of the pump shaft. Therefore, the fluid pressure can increase indefinitely at the dead end of the piston until the system fails. The pressure regulator is used to avoid such circumstances which redirect the excess fluid back to the storage tank. The movement of piston is controlled by changing liquid flow from port A and port B. The cylinder movement is controlled by using control valve which directs the fluid flow. The fluid pressure line is connected to the port B to raise the piston and it is connected to port A to lower down the piston. The valve can also stop the fluid flow in any of the port. The leak proof piping is also important due to safety, environmental hazards and economical aspects.	Fig 6 + Exp 3	9	

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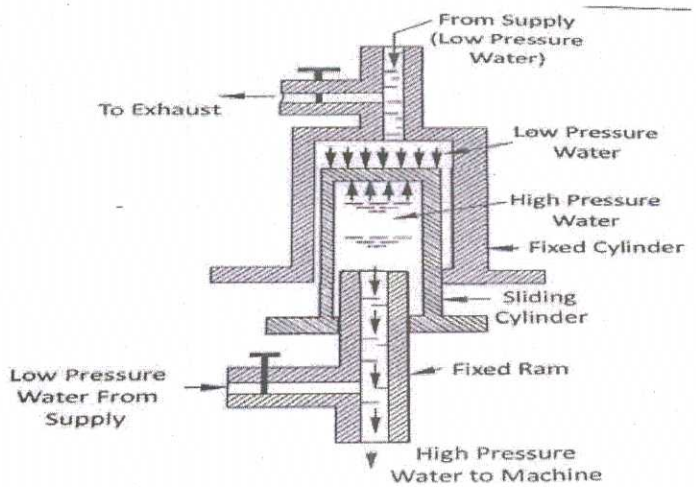
VIII a.	 Fig. 7.16 The Hydraulic Intensifier Hydraulic intensifier is a device used to increase the intensity of pressure of liquid by means of utilizing the energy available from a large amount of liquid at a low pressure. It consists of a fixed ram surrounded by a sliding cylinder which contains high pressure liquid, which is supplied to the machine through the fixed ram. The sliding cylinder is encased by a fixed cylinder which contains low pressure liquid from the main supply. The low pressure liquid from the supply enters the fixed cylinder. The weight of this water presses the sliding cylinder in the downward direction. The water in the sliding cylinder gets compressed due to downward movement of the sliding cylinder and its pressure is increased. This high pressure water is forced out of the cylinder through the fixed ram to the machine.	Fig 5 + Exp 4	9	
VIII b.	1.To regulate the pressure through a system 2.To control and limit flow to the actuator 3.To maintain constant ratio between output and input to actuator 4.To start and shut off the flow 5.To relive the pressure 6.To maintain the direction of flow 7.To amplify the pressure 8.To perform the predetermined operations 9.To provide machine feeds at constant loads and pressure without any compensating mechanism 10.To permit the usage of analog and digital control in automation	1x6	6	15

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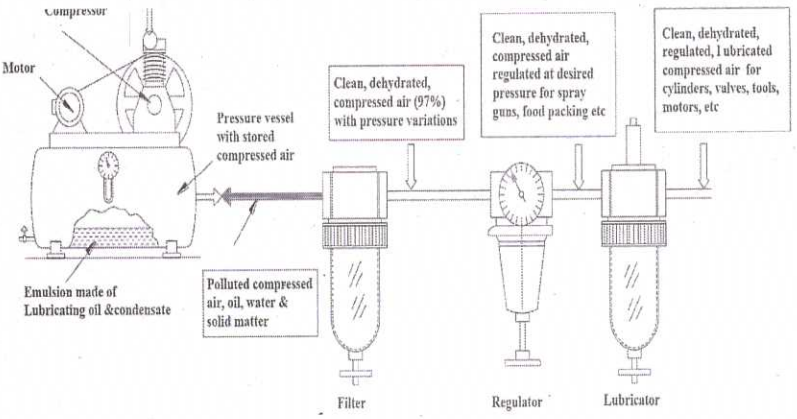
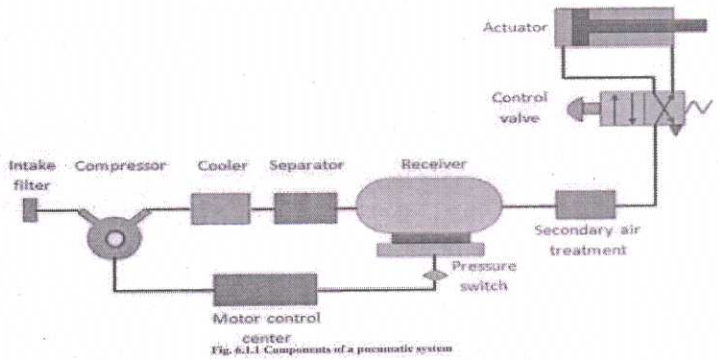
IX a.	HYDRAULICS SYSTEMS 1.It employs a pressurized liquid as a fluid 2.An oil hydraulic system operates at pressures up to 700 bar. 3.Generally designed as closed system 4.The system slows down when leakage occurs 5.Valve operations are difficult 6.Heavier in weight 7.Pumps are used to provide pressurized liquids 8.The system is unsafe to fire hazards 9.Automatic lubrication is provided PNEUMATIC SYSTEMS 1.It employs a compressed gas, usually air , as a fluid. 2. A pneumatic system usually operates at 5-10 bar 3.Usually designed as open system 4.Leakage does not affect the system much 5. Valve operations are easy 6.Lighter in weight 7. Compressors are used to provide compressed gases 8. The system is free from fire hazards 9. Special arrangements for lubrication are needed	1x6	6	
IX b.	 The combination of filter, regulator and lubricator is called FRL unit. The FRL unit is used in all the pneumatic systems and as a service unit they come as a combined unit. In most pneumatic systems, the compressed air is first filtered and then regulated to the specific pressure and made to pass through a lubricator. Thus usually a filter, regulator and lubricator are placed in the inlet line to each air circuit.	Fig 6 + Exp 3	9	15

Qn NO	Scoring indicator	Split up score	Sub Total	Total
X a.	 Fig. 6.1.1 Components of a pneumatic system Important components of a pneumatic system are shown in fig.6.1.1. a) Air filters: These are used to filter out the contaminants from the air. b) Compressor: Compressed air is generated by using air compressors. Air compressors are either diesel or electrically operated. Based on the requirement of compressed air, suitable capacity compressors may be used. c) Air cooler: During compression operation, air temperature increases. Therefore coolers are used to reduce the temperature of the compressed air. d) Dryer: The water vapor or moisture in the air is separated from the air by using a dryer. e) Control Valves: Control valves are used to regulate, control and monitor for control of direction, flow, pressure etc. f) Air Actuator: Air cylinders and motors are used to obtain the required movements of mechanical elements of pneumatic system.	Fig 6 + Exp 3	9	
X b.	1.Quick response to the control system 2.Smooth operation 3.Constant speed can be maintained for both variable loads and constant loads 4.Greater flexibility 5.Energy requirement is less to operate 6.Due to better cushioning, vibration is less 7.Less power consumption 8.Low maintenance cost 9.Energy exhaust from cylinder 10.For explosive atmosphere hydro-pneumatic systems are more suitable.	1X6	6	15

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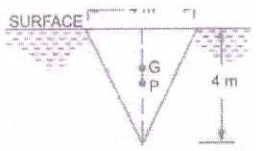
IV b.	**Solution.** Given : Base of plate, $b = 4$ m Height of plate, $h = 4$ m $\therefore$ Area, $A = \frac{b \times h}{2} = \frac{4 \times 4}{2} = 8.0\ m^2$ Sp. gr. of oil, $S = 0.9$ $\therefore$ Density of oil, $\rho = 900\ kg/m^3$. The distance of C.G. from free surface of oil, $\bar{h} = \frac{1}{3} \times h = \frac{1}{3} \times 4 = 1.33$ m. Total pressure (F) is given by $F = \rho g A \bar{h}$ $= 900 \times 9.81 \times 8.0 \times 1.33$ N = **9597.6. N. Ans.**  Fig. 3.8	Equation 2 + 4 mark answer	6	15
V a.	To find V_2, apply continuity equation at 1 and 2 $\therefore \quad A_1V_1 = A_2V_2$ or $V_2 = \frac{A_1V_1}{A_2} = \frac{.0314}{.00785} \times 4.0 = 16.0$ m/s $\therefore$ Velocity head at section 2 $= \frac{V_2^2}{2g} = \frac{16.0 \times 16.0}{2 \times 9.81} =$ **83.047 m. Ans.** (*iii*) Rate of discharge $= A_1V_1$ or A_2V_2 $= 0.0314 \times 4.0 = 0.1256\ m^3/s$ = **125.6 litres/s. Ans.** {$\because 1\ m^3 = 1000$ litres}	Equation 2 + 2x2 mark answer	6	
V b.	(*i*) **Darcy Formula** is given by equation (11.1) as $h_f = \frac{4 . f . L . V^2}{d \times 2g}$ $\therefore$ Head lost, $h_f = \frac{4 \times .00256 \times 50 \times 3^2}{0.3 \times 2.0 \times 9.81} =$ **.7828 m. Ans.** (*ii*) **Chezy's Formula.** Using equation (11.4) $V = C\sqrt{mi}$ here $C = 60$, $m = \frac{d}{4} = \frac{0.30}{4} = 0.075$ m $\therefore \quad 3 = 60\sqrt{.075 \times i}$ or $i = \left(\frac{3}{60}\right)^2 \times \frac{1}{.075} = 0.0333$ But $i = \frac{h_f}{L} = \frac{h_f}{50}$ Equating the two values of i, we have $\frac{h_f}{50} = .0333$ $\therefore \quad h_f = 50 \times .0333 =$ **1.665 m. Ans.**	Equation 2x2 + 2x2.5 mark answer	9	15