BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **ME 415** (Refrigeration and Building Mechanical Systems)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Assume reasonable values for missing data. All symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Establish how an actual cycle differs from a theoretical vapor compression cycle. What is sub-cooling and superheating in vapor compression cycle? Explain with the help of diagram. Why is superheating considered to be good in certain cases? **(15)**

   (b) A fish freezing plant uses multi stage compression refrigeration system with inter-cooling and removal of flash gas. Calculate the power required by the three compressors in a R134a system which serves a 60 TR evaporator at –40°C, 50 TR evaporator at –20°C and 40 TR evaporator at –10°C. The system uses three stage compressions with inter-cooling and removal of flash gas. The condensing temperature is 30°C and the intercooler temperature is –20°C and –10°C. Draw the schematic diagram and P-h diagram of the system. Also calculate the COP of the system. **(20)**

2. (a) Why the outdoor air is required in air conditioning system? Briefly describe the working principle of a central air conditioning system with schematic diagram. Compare all air and all water system with schematic diagram? **(20)**

   (b) Make comparison between ducted split type, multiple split type and VRF system with schematic diagram. Air enters a split air conditioner at 1 atm., 35°C, and 80 percent relative humidity at a rate of 15 m^3/min. The air leaves the cooling section as saturated air at 12.5°C. Part of the moisture in the air that condenses during the process is also removed at 12.5°C. Determine the rate of the heat transfer and moisture from the air. **(15)**

3. (a) Make comparison between different types of fire extinguisher. Classify fire and specify which type of extinguisher will be used for different class of fire. Briefly describe the working principle of sprinkler type fire protection system with schematic diagram. **(25)**

   (b) For a facility having building of Light hazard-II type, 25 rentable floors, each 3500 m^2 net. Floor-to-floor height = 3.7 m. According to BNBC determine the storage capacity of water for the protection of that building. Draw the typical diagram for fire protection system with ground and gravity roof tank with adequate domestic and fire reserve for a building. (according to BNBC) **(10)**

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4. (a) Draw the schematic diagram of a electric traction lift and show its different components. Draw the schematic diagram of different arrangements of elevator doors. **(10)**

(d) Define Interval (I) time, Percent Handling Capacity (PHC) and Average Trip Time for elevator. For an office building, downtown, diversified use, 16 rentable floors above the lobby, each 3500 m^2. net. Floor-to-floor height = 37 m, determine a workable elevator system arrangement. **(20)**

(c) For an escalator of 35°incline, two passengers per step, speed of 0.6 m/s and 600 mm step length, determine the maximum number persons moved per hour. **(5)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

Refrigeration and A/C Data Book will be provided.

5. (a) Why is liquid overfeed cooler type evaporator economically employed in multiple evaporator system? Describe a liquid overfeed cooler evaporator with schematic diagram. **(17)**

(b) Why is steam jet refrigeration system safe for air-conditioning installation? Describe a steam jet refrigeration system with proper diagram and hence discuss its operation, advantages and disadvantages. **(18)**

6. (a) Describe a vapor absorption refrigeration system with proper schematic diagram. Hence, discuss the function of generator, absorber, heat exchangers, analyzer and rectifier. **(17)**

(b) The operating temperatures of a lithium bromide-water absorption system are as: Generator 100°C, condenser 36°C, evaporator 6°C, absorber 28°C. Draw the schematic/block diagram of the system and calculate the followings: **(18)**

(i) The heat supplied to the generator

(ii) The heat reflected at the condenser

(iii) The coefficient of performance of the cycle

The mass flow rate delivered by the aqua pump is 0.45 kg/s.

7. (a) Explain the basic principle of cascade refrigeration cycle. Hence, describe with neat sketches the liquefaction of natural gas by cascade refrigeration method. **(17)**

(b) Describe the thermodynamic principle of liquefaction of gases by expansion. Hence, explain the Joule-Theorem coefficient and isenthalpic curve for flow through a porous plug. **(18)**

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8. Estimate the cooling load of a class-room for 30 students at 3.00 pm for the following conditions: **(35)**

Location : Chittagong

Date April 15

Floor : 10 m × 10 m, 3 m height

Roof : Type 4,100 mm concrete, 25 mm insulation

Walls : 100 mm face brick + air space + 100 mm face brick (type C)

Windows : 15% of wall area on north and west walls 12.5 mm clear glass, U = 3 $W/m^2°C$

Light : 25 W/m^2, florescent bulbs

(i) Assume standard indoor conditions as recommended in ASHRAE.

(ii) Assume no heat transfer through floor, south and east walls.

(iii) Assume reasonable electrical appliances.

T1: Recommended Elevator Intervals & Waiting Times

Facility Type	Interval (sec)	Waiting Time[a] (sec)
OFFICE BUILDINGS		
Excellent service	15–24	9–14
Good service	25–29	15–17
Fair service	30–39	18–23
Poor service	40–49	24–29
Unacceptable service	50+	30+
RESIDENTIAL		
Prestige apartments	50–70	30–42
Middle-income apartments	60–80	36–48
Low income apartments	80–120	48–72
Dormitories	60–60	36–48
Hotels—first quality	30–50	18–30
Hotels—second quality	50–70	30–42

T2: Minimum PHC

Facility	Percent of Population to Be Carried in 5 Minutes
OFFICE BUILDINGS	
Center city	12–14
Investment	11.5–13
Single-purpose	14–16
RESIDENTIAL	
Prestige	5–7
Other	6–8[a]
Dormitories	10–11
Hotels—first quality	12–15
Hotels—second quality	10–12

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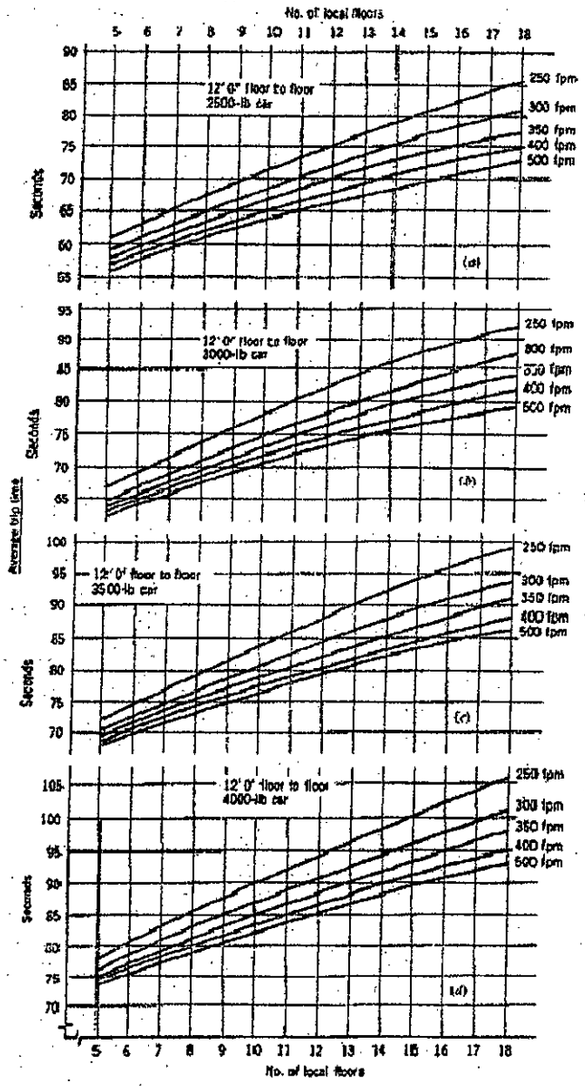
T3: Car Passenger Capacity (p)

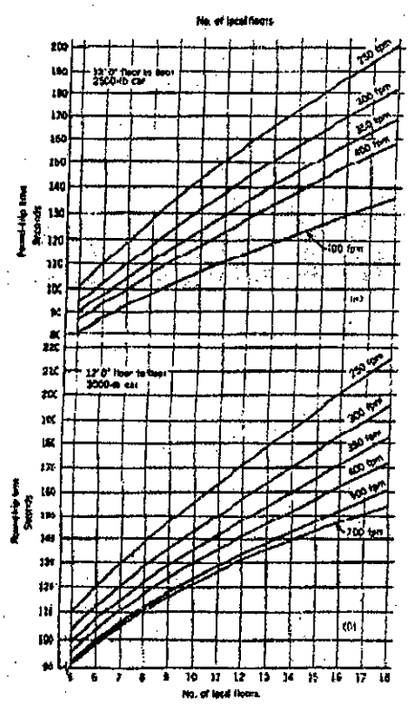
Elevator Capacity lb (kg)	Maximum Passenger Capacity	Normal Passenger[a] Load per Trip
2000 (907)	12	10
2500 (1134)	17	13
3000 (1361)	20	16
3500 (1588)	23	19
4000 (1814)	28	22

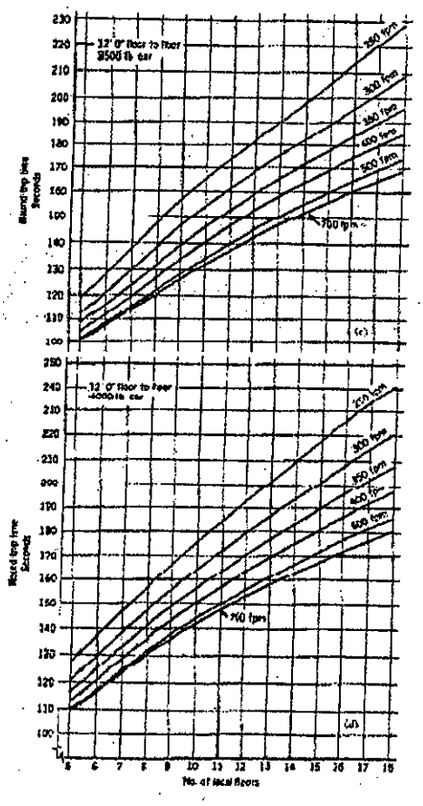
(3)

C1: Average Trip Time (AVRTP)



C2: Round Trip (RT) Time





T4: Population of Typical Buildings

Building Type	Net Area
OFFICE BUILDINGS	FT2 PER PERSON (M2/PERSON)
Diversified (multiple tenancy)	
Normal	110–130 (10–12)[a]
Prestige	150–250 (14–23)
Single tenancy	
Normal	90–110 (8–10)
Prestige	130–200 (12–19)
HOTELS	PERSONS PER SLEEPING ROOM
Normal use	1.3
Conventions	1.9
HOSPITALS	VISITORS AND STAFF PER BED[b]
General private	3
General public (large wards)	3–4
APARTMENT HOUSES	PERSONS PER BEDROOM
High-rental housing	1.5
Moderate-rental housing	2.0
Low-cost housing	2.5–3.0

T5: Office Building Occupancy

Building Height	Net Usable Area as Percentage of Gross Area
0–10 floors	Approximately 80%
0–20 floors	Floors 1–10 approximately 75%
	11–20 approximately 80%
0–30 floors	Floors 1–10 approximately 70%
	11–20 approximately 75%
	21–30 approximately 80%
0–40 floors	Floors 1–10 approximately 70%
	11–20 approximately 75%
	21–30 approximately 80%
	31–40 approximately 85%

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T6: Elevator Equipment Recommendations

Building Type	Capacity		Rise		Minimum Car Speed	
	lb	kg	ft	m	fpm	m/s
Office building	2500	1250	0–125	0–40	350–400	2.0
			126–225	41–70	500–600	2.5
	3000	1360	226–275	71–85	700	3.6
			276–375	86–115	800	4.0
	3500	1600	Above 375	>115	1000	5.0
Hotel	2500	1250	As above		As above	
	3000	1360				
Hospital			0–60	0–20	150	0.63
			61–100	21–30	200–250	1.0
	3500	1600	101–125	31–40	250–300	1.6
	4000	2000	126–175	41–55	350–400	2.0
			176–250	56–75	500–600	2.5
			>250	>75	700	3.6
Apartments			0–75	0–25	100	0.63
	2000	1000	76–125	26–40	200	1.0
	2500	1250	126–200	41–60	250–300	1.6
			>200	>60	350–400	2.0
Stores			0–100	0–30	200	1.0
	3500	1600	101–150	31–45	250–300	1.6
	4000	2000	151–200	46–60	350–400	2.0
	5000	2500	>200	>60	500	2.5

(5)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **ME 417** (Internal Combustion Engines)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Symbols and Abbreviations have their standard meanings.

1. (a) Make a specification for a medium-sized automotive engine using all the classification methods. **(10)**

   (b) Explain the different ways that are used in IC engine pistons for expansion control. What is piston-pin offset? Why is it necessary? **(10)**

   (c) A 4-stroke 4-cylinder IC engine has a bore of 150 mm and a stroke of 200 mm. The engine has a rated speed of 1500 rev/mm and develops 80 kW power. Determine: **(15)**

   (i) the piston speed;

   (ii) the torque development; and

   (iii) the total displacement; and

   (iv) the compression ratio if the volume of the combustion chamber is 9% of the piston displacement.

2. (a) Draw and explain the variation of bsfc, torque and power with respect to speed for an SI engine. List the variables that affect those performance characteristics. **(10)**

   (b) Explain the method of motoring test. Explain its limitations. **(10)**

   (c) What are the various components of a 4-stroke cycle IC engine that need to be lubricated? Explain, with a schematic, how the lubrication of these components achieved. **(15)**

3. (a) Why is it necessary to cool IC engines when in operation. What might be the effects on engine performance parameters had the water cooling system not been pressurized? Explain. **(10)**

   (b) Explain SIT with a suitable diagram. How can one choose suitable fuels for SI and CI engines using the diagram so as to avoid knocking? **(10)**

   (c) Using simple sketches, list the various fuel distribution systems used in CI engines. Compare their relative merits and demerits. **(15)**

Contd P/2

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4. (a) Draw and label the P-V diagrams for the following air-standard cycles: Otto cycle, Miller cycle, and Atkinson cycle. In your opinion, is it possible to use Miller cycles with the modern engine technologies? Give reasons. **(10)**

   (b) What are the differences between SI and CI engine fuel injection systems? Explain the similarities and dissimilarities of CI engine injection and GDI systems. **(10)**

   (c) Discuss in detail, with necessary sketches, the formation and control of particulate emissions from CI engines. **(15)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Explain the phases and characteristics of SI engine combustion. **(10)**

   (b) Explain the knock phenomenon in SI engines and present the factors to reduce such knocking. **(15)**

   (c) Write short reasoning for **(10)**

   (i) advancement of spark timing for lean SI engine

   (ii) advancement of spark timing for higher engine speed in SI engines.

6. (a) Explain the phases and characteristics of CI engine combustion. **(10)**

   (b) Make a brief comparison between knocks in SIE and CIEs. **(10)**

   (c) Write short notes on **(15)**

   (i) flammability limits.

   (ii) MBT timing of engines.

   (iii) Gas turbine combustion zones.

7. (a) Make a brief comparison Otto cycle and SI engine cycles. Draw typical P-v diagram and point-out the losses in actual cycle. **(10)**

   (b) Briefly explain the similitude principle as applied in engine design. Give an example to show how the effects of inlet air temperature is addressed. **(10)**

   (c) Write short-reasoning for:

   (i) Slightly high break power is available with slightly rich mixture.

   (ii) SI engine exhaust temperature is high.

   (iii) knocking is always present in CI engines. **(15)**

Contd P/3

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8. (a) Briefly present valve sizing procedure with required equations. **(10)**

   (b) Define η_{th}, bmep and bsfc. Diagrammatically show typical relationships between these parameters for SI engines **(10)**

   (c) Write short reasoning for: **(15)**

   (i) exhaust valves are smaller in size.

   (ii) part load efficiency of CI engines are higher.

   (iii) bmep of SI engines are higher than CI engine valves.

L-4/T-1/ME Date : 06/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **ME 421** (Fluid Machinery)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

Assume reasonable data for missing data. The symbols have their usual meanings.

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) State and explain the impulse and momentum principle for fluid machinery and hence derive the expressions for work done and efficiency of a curved moving vane when a water jet strikes it. Give your comments on the direction of flow for making the system efficient. **(18)**

   (b) A jet of water striking a curved vane with an absolute velocity of 35 m/s. The jet makes an angle 30° with the direction of motion of blade at inlet and 120°at outlet. If the velocity of blade is 16 m/s and the jet strikes the blade without shock, find the blade angles at inlet and outlet. Find also the work done and hydraulic efficiency. **(17)**

2. (a) Write the recommended shape and dimensions of the bucket of pelton wheel give the reasons why this kind of shape is recommended. **(7)**

   (b) Derive an expression for the number of buckets on the wheel of pelton turbine for efficient use of jet. **(10)**

   (c) A 1200 m long pipe is connected to three different single jet pelton wheels. The head of water is 400 m and the speed of each turbine is 600 rpm. The Cv of nozzle is 0.98 and f = 0.025 for the pipe. For each turbine specific speed is 18 and the overall efficiency is 86%. If the head loss due to friction in pipe is 13 m of water, find (i) total power delivered, (ii) flow rate, (iii) nozzle and pipe diameters. **(18)**

3. (a) Mention the functions of major components of Francis turbine. **(7)**

   (b) What is specific speed of a turbine? Derive an expression for the specific speed of a turbine and explain its practical utility. **(10)**

   (c) An inward flow reaction turbine develops 2600 kW at 300 rpm under a head of 32 m. The speed ratio is 0.95 and the flow ratio is 0.35. The overall efficiency of the turbine is 82% and the discharge is radial at the outlet. If the hydraulic losses are 20% of the available energy, find the guide blade angle at inlet, blade angle at inlet, diameter of wheel at inlet and the width of the wheel at inlet. **(18)**

Contd P/2

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4. (a) Draw the constant efficiency curve of a hydraulic turbine and explain its physical significance. **(8)**

(b) Describe the working principle of a torque converter and compare its performance with fluid coupling. **(12)**

(c) A turbine develops 2200 kW under a head of 40 m at 210 rpm. The flow rate of water is 3 m^3/s and the diameter of runner is 1.8 m. A geometrically similar turbine is generating 3200 kw at 50 m water head. Find out the runner diameter, speed, flow rate of water and specific speed of the second turbine. **(15)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Define the terms 'slip' and 'coefficient of discharge' in relation to reciprocating pumps. Under what circumstances does the coefficient of discharge become greater than unity? **(6)**

(b) A single acting reciprocating pump has a cylinder of bore 8 cm and stroke 12 cm. Water is to be drawn from a sump 3.5 m below the axis of the cylinder through a pipe of 4 cm diameter and 5 m length. The pump delivers the water to a tank at a height of 12 m through a 20 m long 4 cm diameter pipe. If separation occurs at 0.78 kg/cm^2 below the atmospheric pressure, find the maximum speed at which the pump can lift water. **(10)**

(c) A single acting reciprocating pump has a plunger of diameter 15 cm and a stroke 30 cm. The lengths of the suction and delivery pipes are 5 m and 20 m, respectively and their diameter is 7.5 cm. The suction and delivery heads are 3.50 m and 8 m, respectively. Find the pressure head in the cylinder at the beginning, middle and end of the suction and delivery strokes. Take $f = 0.0075$ and speed of the pump as 30 rpm. Find also the hp required to drive the pump. **(19)**

6. (a) What is air vessel? Why and where are air vessels installed in a reciprocating pump? **(8)**

(b) A single acting reciprocating pump has piston moving in simple harmonic motion. What is the ratio of work done against friction when the air vessels are fitted the work done without air vessels? **(10)**

(c) A double-acting, single cylinder reciprocating pump has a bore of 19 cm and stroke 38 cm and runs at 36 double-strokes/min. The center of the cylinder is 3.66 m above the suction level and the discharge is 30.48 m above the pump. The suction and delivery pipes, each 10.16 cm dia., are 9.14 m and 60.96 m, respectively.

Contd P/3

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Contd...Q. No. 6(c)

Large air vessels are provided 1 m away from the pump on the suction side and 2 m away on the discharge side. If f = 0.032 and neglecting entrance and exit losses for the pipes, estimate for the beginning of a stroke: **(17)**

(i) the heads in the two ends of the cylinder (ii) the load on the Piston rod.

7. (a) Is there any limit to the suction lift of centrifugal pump? If yes, then what is the limit and why the suction lift should not be more than this limit? **(6)**

(b) How does pressure change in different location of a centrifugal pumping system? Prove that the manometric head, **(12)**

H_m = Actual rise of pressure head in impelling + Rise of pressure head in volute chamber – Head losses in casing.

(c) A centrifugal pump has a total lift of 15 metres from well to delivery tank. The wheel is 1.50 meters above the well water surface. The velocity of delivery is 1.50 m/sec, the radial velocity of flow through the wheel is 3 m/sec, the tangent to the vane at exit from the wheel makes an angle of 120° with the direction of motion. The water enters the wheel radially. Find **(17)**

(i) the velocity of wheel at exit,

(ii) the pressure head at exit from the wheel,

(iii) the velocity head at exit from the wheel, and

(iv) desirable direction for the fixed guide vanes.

Neglect friction and other losses.

8. (a) What do you understand by the specific speed of a pump? Derive the similarity laws used in prototype and model of a centrifugal pump. **(10)**

(b) It is required to predict the performance of a large centrifugal pump from that of a scale model of one-fourth the diameter. The model absorbs 20 hp when pumping under the head of 6 m at its speed of 400 rpm. The prototype pump is required to pump against a head of 18 m what will be its working speed, the horse power required to drive it, and what will be the ratio of the quantities discharged by the large pump and the model? **(10)**

(c) A centrifugal pump has an impeller of 0.5 m outer diameter and when running at 600 rpm, discharges water at the rate of 8000 liters/min against a head of 8.5 m. The water enters the impeller without shock. The inner diameter is 0.25 m and the vanes are set back at outlet at an angle 45° and the area of flow is constant as 0.06 m^2. Determine (15)

(i) the manometric efficiency of the pump, (ii) the vane angle at inlet, and

(iii) the least speed at which the pump commence to work.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 . B. Sc. Engineering Examinations 2018-2019

Sub : **ME 423** (Fluids Engineering)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols and abbreviations have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) What do you mean by pseudocritical temperature and pseudocritical pressure? **(5)**

(b) What is compressibility factor or the gas deviation factor? Explain its importance in gas flow. **(5)**

(c) With a sketch show and discuss the comparison of the pressure drop predicted by different flow equations assuming same pressure at the inlet. **(5)**

(d) A natural gas pipeline, NPS 16, 0.250 in. wall thickness, 50 mi long, with a branch pipe (NPS 8, 0.250 in, wall thickness, 15 mi long), as shown in Figure Q. 1(c), is used to transport 100 MMSCFD gas (gravity = 0.6 and viscosity = 0.000008 lb/ft-s) from location A to B. At B (milepost 20), a delivery of 30 MMSCFD occurs into the branch pipe BE. The delivery pressure at E must be maintained at 300 psig. The remaining volume of 70 MMSCFD is shipped to the terminus C at a delivery pressure of 600 psig. **(20)**

Assume a constant gas temperature of 60°F and a pipeline efficiency of 0.95. The base temperature and base pressure are 60° and 14.7 psia, respectively.

Take, compressibility factor Z = 0.88.

(i) Using Panhandle A equation, calculate the inlet pressure required at A. Neglect the elevation effects (i. e. take $s = 0$).

$$Q = 435.87E\left(\frac{T_b}{P_b}\right)^{1.0788}\left(\frac{P_1^2 - e^s P_2^2}{G^{0.8539} T_f L_e Z}\right)^{0.5394} D^{2.6182}\,(\text{USCS units})$$

(ii) Is a pressure regulator required at E?

(iii) If the inlet flow at A drops to 60 MMSCFD, what is the impact in the branch pipeline BE if the flow rate of 30 MMSCFD is maintained?

Contd P/2

2. (a) A natural gas pipeline DN 500 with 12 mm wall thickness is 60 km long. The gas flow rate is 5.0 Mm^3/day at 20°C. Calculate the inlet pressure required for a delivery pressure of 4 MPa (absolute), using the General Flow equation with the modified Colebrook-White friction factor. The pipe roughness = 0.015 mm. In order to increase the flow rate through the pipeline, the entire line is looped with a DN 500 pipeline, 12 mm wall thickness.

Assuming the same delivery pressure, calculate the inlet pressure at the new flow rate of 8 Mm^2/day.

The gas gravity = 0.65 and viscosity = 0.000119 Poise. The compressibility factor Z = 0.88. The base temperature = 15°C, and the base pressure = 101 kPa. If the inlet and outlet pressures are held the same as before, what length of the pipe should be looped to achieve the increased flow? **(25)**

Use the following equations.

$$Re = 0.5134\left(\frac{P_b}{T_b}\right)\left(\frac{GQ}{\mu D}\right)(\text{SI units})$$

Modified Cloebrook-White equations:

$$F = -4Log_{10}\left(\frac{e}{3.7D} + \frac{1.4125F}{Re}\right)(\text{USCS and SI units})$$

General Flow equation:

$$Q = 5.747\times10^{-4}F\left(\frac{T_b}{P_b}\right)\left[\frac{(P_1^2 - P_2^2)}{GT_fIZ}\right]^{0.5} D^{2.5}(\text{SI units})$$

(b) What is hydrotransport? Give four examples of hydrotransport in industrial scale. **(10)**

3. (a) Discuss on 'in-situ concentration' and 'delivered concentration' in a slurry flow. Establish a relation between them as a function of 'hold up'. **(8)**

(b) What is 'terminal settling velocity'? Derive the equation of terminal settling velocity for the Stoke's law range and the Newton's law range. **(12)**

(c) Estimate the terminal velocity and hindered settling velocities of sand particles of 200 micron size (Take, density = 2650 kg/m^3, shape factor K = 0.26 and velocity ratio ζ = 0.55) in water at room temperature (Take, density = 998 kg/m^3 and dynamic viscosity = 1.002 × 10^{-3} Pa-s). Use the following correlation. **(15)**

$$\frac{V_t}{V^*} = \frac{Re^*}{3\left(1 + 0.08Re^{*1.2}\right)} + \frac{2.8}{1 + 30000Re^{*-3.2}}$$

4. (a) What is rheogram? Discuss various rheological models. **(10)**

(b) A phosphate-slimes clay-water slurry of 1130 kg/m^3 density is to be pumped through a 1 km long pipeline of 305 mm diameter. Model test with this slurry have been carried out using a pipe of 203 mm diameter and the data of V_m and j_m given below. **(25)**

Run#	1	2	3	4	5	6	7	8	9
V_m(m/s)	0.53	1.52	2.00	2.59	3.24	3.81	4.43	5.12	5.64
J_m	0.089	0.10	0.102	0.105	0.108	0.110	0.113	0.119	0.13

(i) Do the appropriate scaling of the data points for the large diameter pipe.

(ii) Plot V_m vs-j_m and find the laminar to turbulent transition velocities for both pipes.

(iii) Calculate the required head and pressure at the pump for a flow rate of 0.35 m^3/s.

Contd P/3

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SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

Required tables and charts are supplied. Assume reasonable values for missing data.

5. (a) A pipe of welded steel and a diameter of 18 in connects two reservoirs having a difference in water surface level of 20 ft. **(17)**

(i) If only pipe friction is considered, what is the discharge?

(ii) If local losses for a sharp edged entrance, a fully open gate valve near the pipe exit, and the pipe exit are considered, how much does the computed discharge change?

(iii) If the gate valve in part (ii) were only ½ open, what would be the discharge?

(b) A pumping system as shown in Fig. for Q. No. 5(b) follows the pump characteristics curve in Fig. for Q. No. 5(b). Estimate the flow rate and calculate (i) the pump power requirement, (ii) The pressure at the pump inlet and outlet. Also sketch the EGL and the HGL of the system. **(18)**

6. (a) Find the distribution of flow and drop in HGL for the Three parallel pipe arrangement as shown in Fig. for Q. No. 6(a). Use variable friction factors with $\nu = 10^{-6}$ m^2/s. The total discharge of water is 0.025 m^3/s. The following equations can be used for friction factors. **(18)**

$$f = 1.325\left\{ln\left[0.27\left(\frac{e}{D}\right) + 5.74\left(\frac{1}{Re}\right)^{0.9}\right]\right\}^{-2}$$

$$f = 1.325\left\{ln\left[0.27\left(\frac{e}{D}\right)\right]\right\}^{-2}$$

(b) A three-branch piping system with given data is shown in Fig. for Q. No. 6(b). Determine the flow rates Q_i and the piezometric head H at the junction. **(17)**

7. (a) Discuss the basic principles for pipe network analysis. **(5)**

(b)The flow of water in a pipe network is shown in Fig. for Q. No. 7(b). Compute:

(i) the hydraulic grade line through the system, (ii) The pressure at each node. **(15)**

(c) For the network shown in Fig. for Q. No. 7(c) (i) the Q-equations, (ii) the H-equations, and

(iii) the ΔQ –equations. Pipe 3 contains a pressure reduction valve 200 ft downstream from node-1 which is set to maintain HGL = 430 ft on the discharge side. Use the notation k_i and n_i in equations where i is the pipe number. **(15)**

8. (a) Differentiate between "quasi-steady flow" and "rigid-column flow" with examples. **(5)**

(b) From the fundamental concept of fluid hammer in pipe derive the Joukowsky equation and hence find an expression for elastic modules of pipe wall. **(15)**

(c) A steel pipe of E = 207 MPa, L = 1600 m, D = 300 mm, e = 10 mm conveys water at 20°C. The initial velocity is 1.0 m/s. A valve at the downstream end is closed so rapidly that the motion is considered to be instantaneous, reducing the velocity to zero. Determine (i) the pressure pulse wave speed in pipe, (ii) the speed of sound in an unbounded water medium, (iii) The pressure rise at the valve, (iv) the time it takes for the wave to travel from the valve to the reservoir at the upstream end, and (v) the period of oscillation. **(15)**

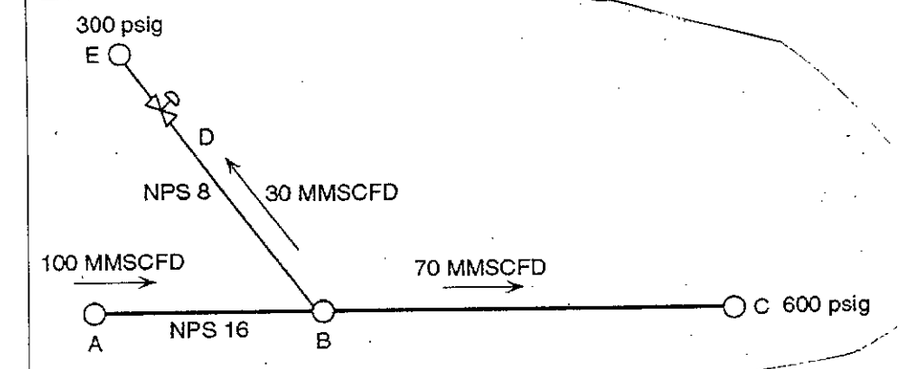


Figure for Q1c

Table 2.1 PIPE ROUGHNESSES

Material	e, mm	e, in
Riveted Steel	0.9 - 9.0	0.035 - 0.35
Concrete	0.30 - 3.0	0.012 - 0.12
Cast Iron	0.26	0.010
Galvanized Iron	0.15	0.006
Asphalted Cast Iron	0.12	0.0048
Commercial or Welded Steel	0.045	0.0018
PVC, Drawn Tubing, Glass	0.0015	0.000 06

Table 2.5 Loss Coefficients for Fittings

Fitting	K_L
Globe valve, fully open	10.0
Angle valve, fully open	5.0
Butterfly valve, fully open	0.4
Gate valve, fully open	0.2
3/4 open	1.0
1/2 open	5.6
1/4 open	17.0
Check valve, swing type, fully open	2.3
Check valve, lift type, fully open	12.0
Check valve, ball type, fully open	70.0
Foot valve, fully open	15.0
Elbow, 45°	0.4
Long radius elbow, 90°	0.6
Medium radius elbow, 90°	0.8
Short radius (standard) elbow, 90°	0.9
Close return bend, 180°	2.2
Pipe entrance, rounded, r/D < 0.16	0.1
Pipe entrance, square-edged	0.5
Pipe entrance, re-entrant	0.8

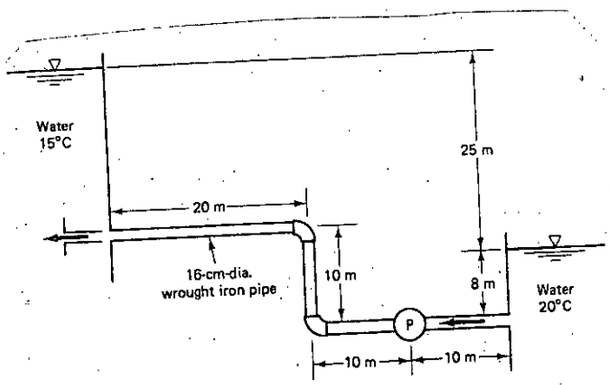
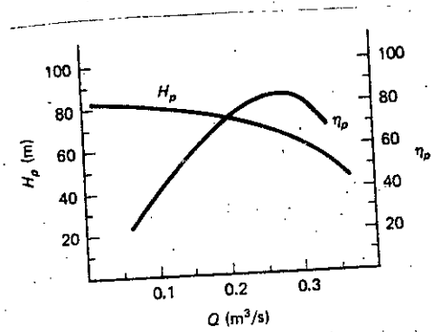
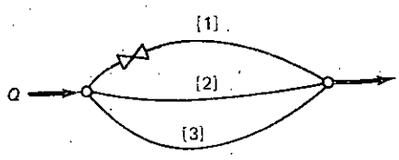


Fig. for Q. 5(b)

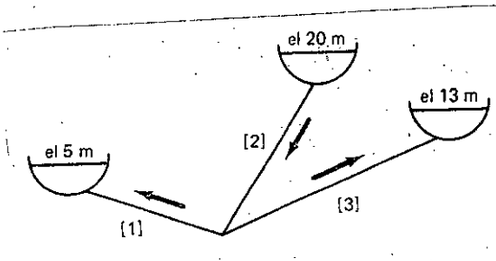


Head & efficiency curve for pump in Q. No. 5(b)



Pipe	L (m)	D (m)	e (mm)	ΣK
1	100	0.05	0.1	10
2	150	0.075	0.2	3
3	200	0.085	0.1	2

Fig. for Q. No. 6 (a)



Pipe	L (m)	D (m)	f	ΣK
1	500	0.10	0.025	3
2	750	0.15	0.020	2
3	1000	0.13	0.018	7

Fig. for Q. No. 6 (b)

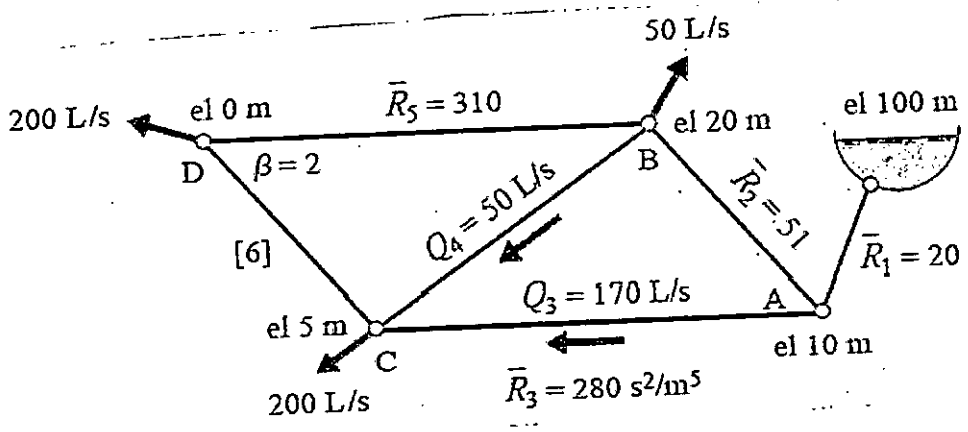


Fig. for Q. No. 7(b)

Pipe	K	n
1	1.93	1.935
2	4.44	1.940
3	3.50	1.840
4	47.90	1.866
5	7.67	1.917

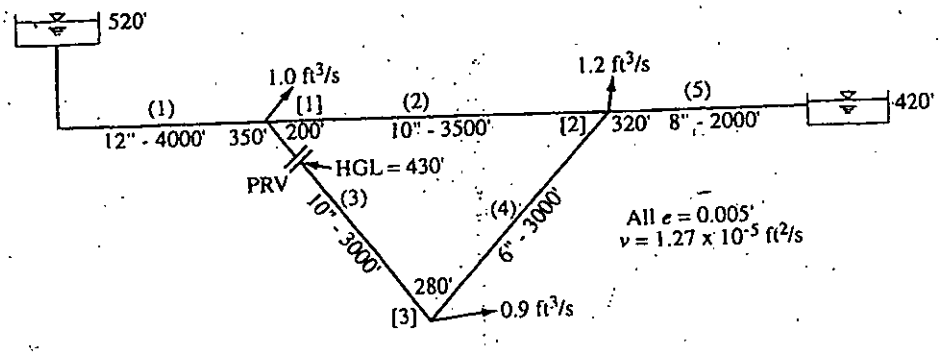


Fig. for Q. No. 7(c)

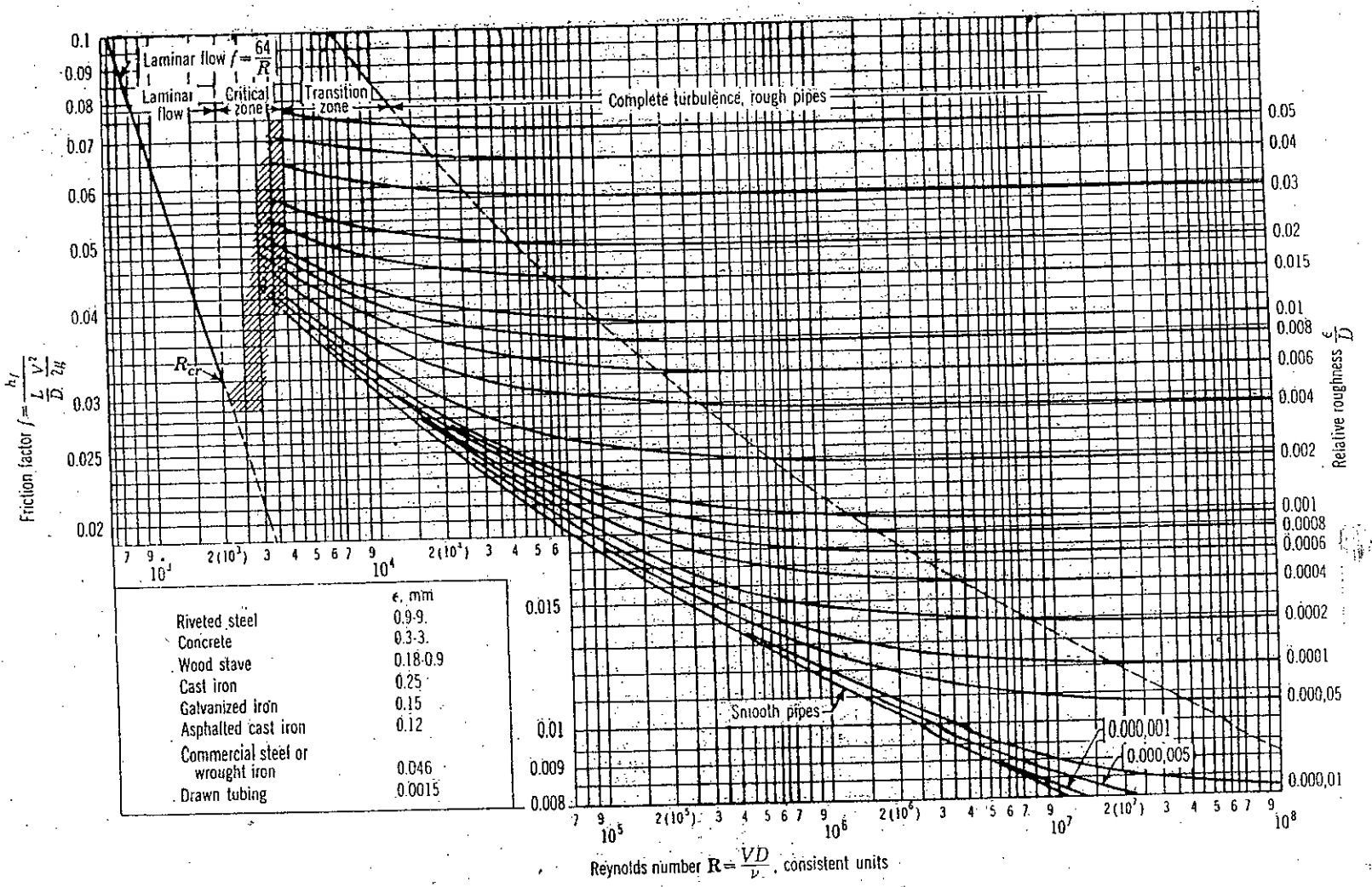


Figure 5.32 Moody diagram.

=7=

APPENDIX-7

Physical Properties of Water in SI Units.

Temp. °C	Specific weight γ kN/m³	Density ρ kg/m³	Viscosity. μ x10³ N.s/m²	Kinematic viscosity,nu ν x10⁶ m²/s.	Surface tension σ N/m	Vapour pressure, P_v kN/m² abs.	Bulk modulus of elasticity, E x 10⁻⁶ kN/m².
0	9.805	999.8	1.781	1.785	0.0756	0.61	2.02
5	9.806	1000.0	1.518	1.519	0.0749	0.87	2.06
10	9.803	999.7	1.307	1.306	0.0742	1.23	2.10
15	9.798	999.1	1.139	1.139	0.0735	1.70	2.15
20	9.789	998.2	1.002	1.003	0.0728	2.34	2.18
25	9.779	997.0	0.890	0.893	0.0720	3.17	2.22
30	9.767	995.7	0.798	0.800	0.0712	4.24	2.25
40	9.737	992.2	0.653	0.658	0.0696	7.38	2.28
50	9.697	988.0	0.547	0.553	0.0679	12.33	2.29
60	9.658	983.2	0.466	0.474	0.0662	19.92	2.28
70	9.600	977.8	0.404	0.413	0.0644	31.16	2.25
80	9.557	975.8	0.354	0.364	0.0626	47.34	2.20
90	9.499	965.3	0.315	0.326	0.0608	70.10	2.14
100	9.438	958.4	0.282	0.294	0.0589	101.33	2.07

(Example : Here, if E x 10^{-6} = 2.02, then E = 2.02 x 10^6 kN/m²).

L-4/T-1/ME Date : 24/10/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **IPE 431** (Machine Tools)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Describe the mechanism involved in transfering the relational motion of Lead screw and feed rod to linear motion in the drive system of engine lathe. **(10)**

   (b) What are the purposes of tail stock in a lathe machine? **(5)**

   (c) What do you understand by precision threads? How do you cut precision threads in a lathe? **(8)**

   (d) Discuss the purposes and related mechanism involved in different chucks and Mandrels. **(12)**

2. (a) Discuss the two feed method of taper turning in detail. **(10)**

   (b) Discuss the necessity of collet chucks in Bar type turret lathe. **(8)**

   (c) In which case do you need differential indexing? Explain the principle of differential indexing **(12)**

   (d) Discuss the necessity of adjustable sector/finger in indexing process. **(5)**

3. (a) In which case you can cut in volute profile by milling machine? Explain briefly. **(10)**

   (b) How much do you need to pre-load a bearing for better machining accuracy? Explain with necessary sketches. **(12)**

   (c) Why the distance between the inlet and outlet of a vane pump should cover at least two vanes? The delivery rate of a twin gear pump is 0.15 m^3/min at 1400 rpm. The pitch circle diameter of the gears is 12 cm and they are 5 cm wide. Calculate their module. What is the maximum pressure that the pump can develop it is powered by a 15 kW motor? Assume the coefficients of mechanical and leakage losses as 0.3 each. **(13)**

4. (a) Show that the difference in the number of teeth of adjacent gears of a cluster must be at least 4 (assume that all the gears have the same modules). **(12)**

   (b) Explain the working principle of Wuelel-kopp Tourator with neat sketch. Show that, its transmission ratio is independent of the effective disc diameter and depends entirely upon the angular position of the shafts which carry the spheres. **(13)**

   (c) List the advantages of infinitely variable drive. Why the term 'positive' is used for Positive Infinitely variable (PIV) drive system? **(10)**

Contd P/2

IPE 431

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE.**

5. (a) Show that, the maximum relative loss of economic cutting speed and loss of production volume are constant for a certain machine, which is following GP series. **(10)**

   (b) Name and explain the two factors that determine the 'best structural diagram' from all the probable structural diagrams as a part of the gearbox design process. Based on these two factors select the optimum diagram from the six structural diagrams shown in Fig. for Q. No 5(b). **(15)**

   (c) What are the influences of diameter, speed, module, and teeth number of a gear designed of a given material for a given power on kinetic energy? Assume the gears are the only power transmitting elements of the gearbox. **(10)**

6. (a) With the help of neat sketches, differentiate surrounding dovetail slideways from surrounded dovetail slideways. Mention the advantages and limitations of using plastics as slideway materials. **(10)**

   (b) Deduce the mathematical relationship relationship among number of speeds z, speed range ratio R_n and progression ratio φ for a Geometric Progression (GP) series. The requirement of minimum and maximum speeds are 20 rpm and 900 rpm respectively. The number of speed steps is 12. Calculate the different speeds possible with the GP series. **(10)**

   (c) What are the most frequently used foundations for machine tool installation. Provide necessary sketches for each of them. Discuss the general recommendations for installation of a knee-and-bed type milling machine. **(15)**

7. (a) List the main specifications of a typical gear shaper machine. What is the principal movement of a gear shaper machine? Do we need any auxiliary movement for cutting spur gear using the gear shaper machine? Explain with sketches. **(10)**

   (b) With the help of kinematic diagram as shown in Fig. for Q. No. 7(b), derive the equations for setting up **(10)**

   (i) Coarse feed (circular)gear train.

   (ii) Indexing gear train

   (c) Gear hobbing machines are more productive in gear manufacturing than milling machines. -- Do you agree? Explain why. Draw a typical gear hob and label inclination angle and lead angle. With necessary drawings show how inclination angle of the hob is determines for cutting spur gears and helical gears using gear hobbing machines. **(15)**

8. (a) What are the common operations that can be performed by grinding machines? With neat sketches explain the principal and feed movements available is planetary grinders and surface grinders with revolving tables. **(10)**

Contd P/3

IPE 431

Contd..... Q. No. 8

(b) Explain how different motors ensure all the movements required in a cylindrical grinding machine. Use kinematic diagram shown in Fig. for Q. No. 8(b) as the reference. **(15)**

(c) Discuss he importance of microfinishing machines. Briefly, explain principles of operation of a honing machine. **(10)**

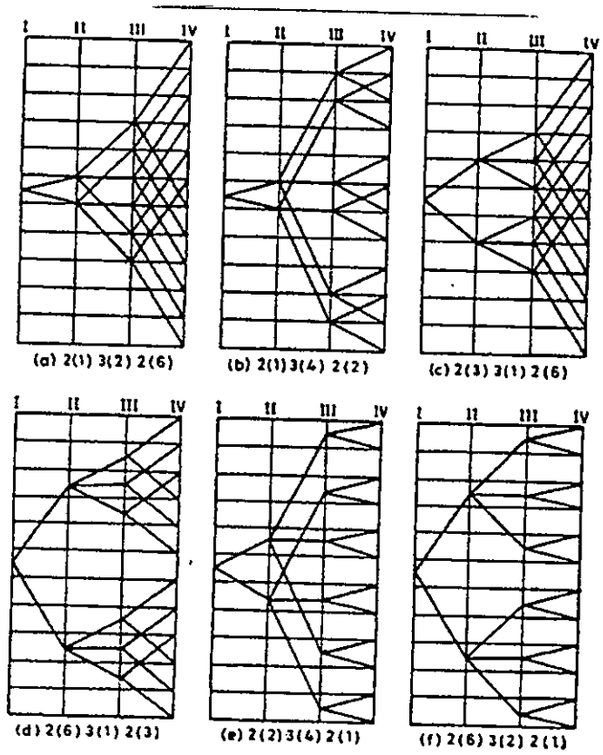


Fig. for Q. No. 5(b)

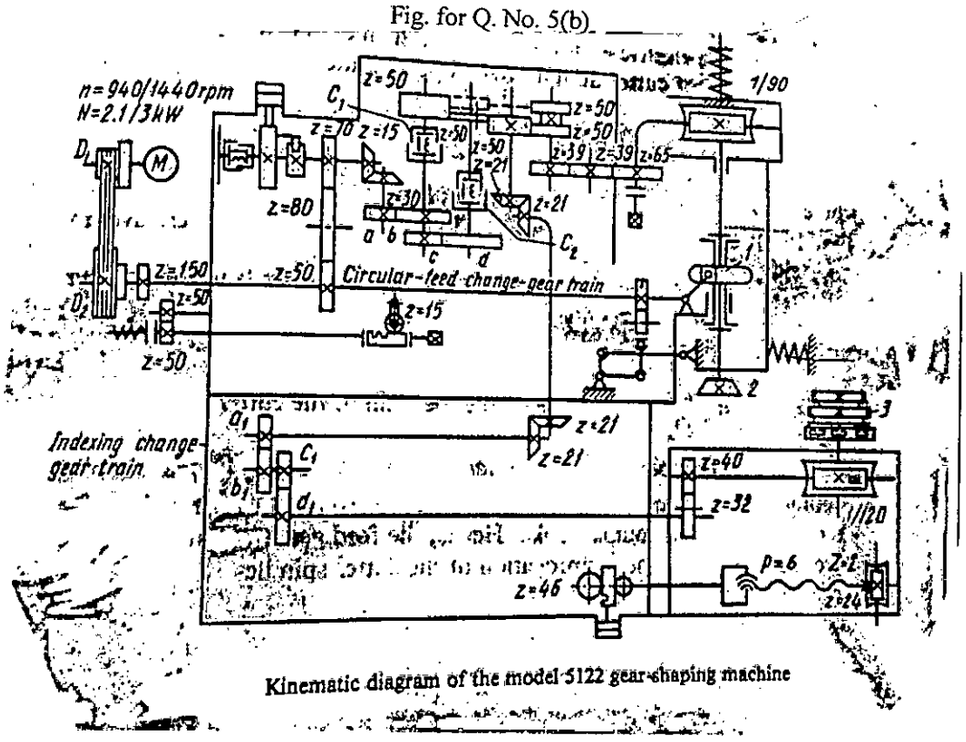


Fig. for Q. No. 7(b)

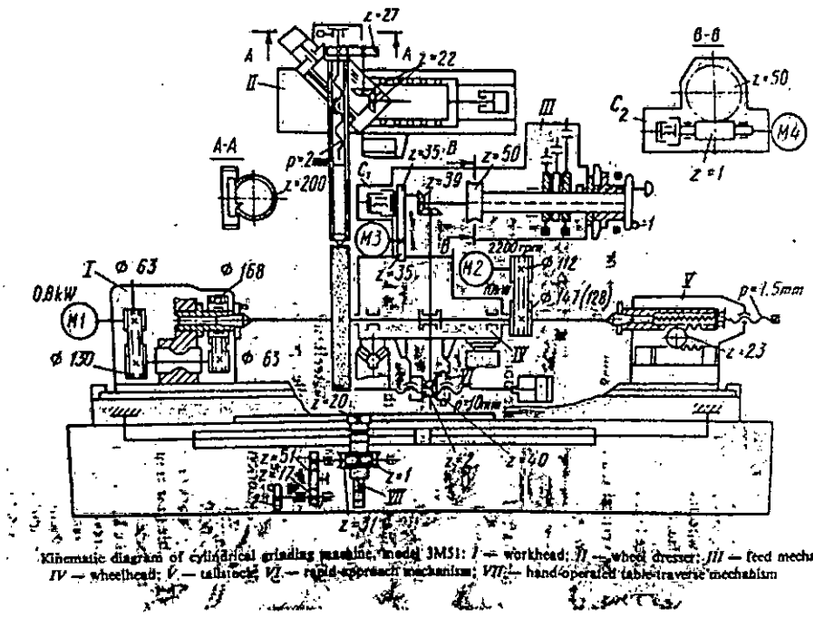


Fig. for Q. No. 8(b)

Date : 29/10/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B.Sc. Engineering Examinations 2018-2019

Sub : **ME 441** (Theory of Structures)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) With neat sketches, compare and contrast a Cantilever beam and a Cantilever plate under uniform loading with reference to the following issues: **(18)**

   (i) Governing differential equation

   (ii) Physical conditions at the bounding edges

   (iii) Physical conditions at the right lateral free edge, when rotational springs are attached to it.

   (b) With reference to a differential element of a thin plate, show that shear forces can be expressed as a summation of partial derivatives of moments. **(17)**

2. Describe Navier's classical method to obtain lateral deflection of simply-supported thin rectangular plates. A thin square plate of unit dimensions (1×1×h) is simply-supported along all its edges, and carries a uniformly distributed loading of unit intensity. Determine the following for the plate: **(35)**

   (i) Distribution of lateral deflection (ii) Distribution of bending moments

   (iii) Maximum value of lateral deflection (iv) Maximum value of bending moments.

3. (a) Consider a simply-supported beam of length L and moment of inertia I, which is subjected to a concentrated load, P at its mid-span.

   Justify the suitability of the following function as the elastic curve of the beam using Potential Energy method $y(x) = y_0 \sin\left(\frac{\pi x}{L}\right)$ **(18)**

   (b) For the spring system shown in Fig. Q. 3(b), show the details of obtaining the global stiffness matrix equation to determine the nodal displacements by an Energy method. **(17)**

4. (a) Derive the equations of motion for the vibratory system shown in Fig. Q 4(a) using Lagrange's energy method. Expressing the equations in terms of a single matrix equation, determine the following: **(18)**

   (i) Inertia matrix (ii) Stiffness matrix (iii) Dynamic matrix

   (b) Consider a both ends hinged straight slender column subjected to an axial compressive load, ρ.

   "If one of the ends of the column is replaced by a clamped one, the increase in bucking load is approximately 100%" - justify mathematically. **(17)**

Contd P/2

ME 441

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Explain plane stress and plane strain conditions of analysis using practical examples. **(15)**

   (b) Derive the conditions for limiting value of Poisson's ratio of an isometric material. **(20)**

6. (a) How many engineering constants are required to define the constitutive relations of an isometric material? Derive the expressive for the stiffness matrix of an isometric material in terms of engineering constants. **(15)**

   (b) The stress field within an elastic body is given by

$$\sigma_{xx} = \left(50x^3 + 2y\right)psi$$
$$\sigma_{xy} = \left(40x^3 + 500\right)psi$$
$$\sigma_{zz} = \left(60y^2 + 30z^3\right)psi$$
$$\tau_{xy} = \left(100z + 80y^2\right)psi$$
$$\tau_{yz} = 0$$
$$\tau_{zx} = \left(xz^3 + 40x^2y\right)psi$$

   Taking E = 30×10^6 psi and μ = 0.25, calculate the state of strain at a point (2,2,1) within the body. Find the body force distributions required to maintain equilibrium. Find also the components of body force at point (2, 2, 1). **(20)**

7. (a) Justify the suitability of the following stress function for the problem shown in Figure 7(a).

$$\phi = \frac{P}{4La^3}\left[\frac{x^3y^3}{6} - \frac{xy^5}{10} - \frac{a^2x^3y}{2} + \left(\frac{a^2}{5} - \frac{L^2}{6}\right)y^3x + \left(\frac{a^2L^2}{2} - \frac{a^4}{10}\right)xy - \frac{a^3x^3}{3}\right] \quad \textbf{(20)}$$

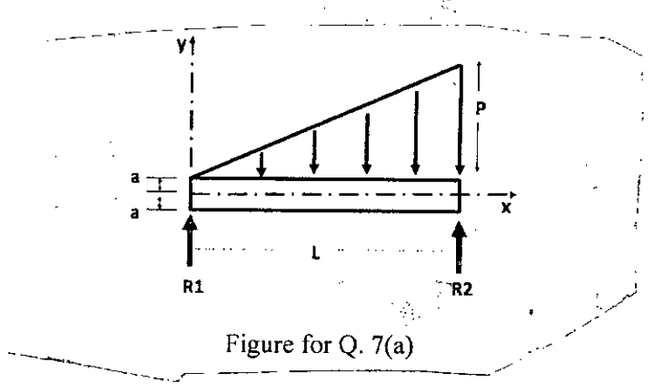


Figure for Q. 7(a)

   (b) Show that the stress function for a torsion problem is governed by the following relation

$$\nabla^2\phi = -2G\theta \quad \textbf{(15)}$$

   The symbols have their usual meaning.

8. (a) Using a suitable stress function for a solid cylinder with triangular cross-section under torsion, determine the distribution of relevant stress components and warping displacement within the cylinder. **(20)**

   (b) Derive the generalized torque-stress function relation for a cylindrical shaft under torsion. **(15)**

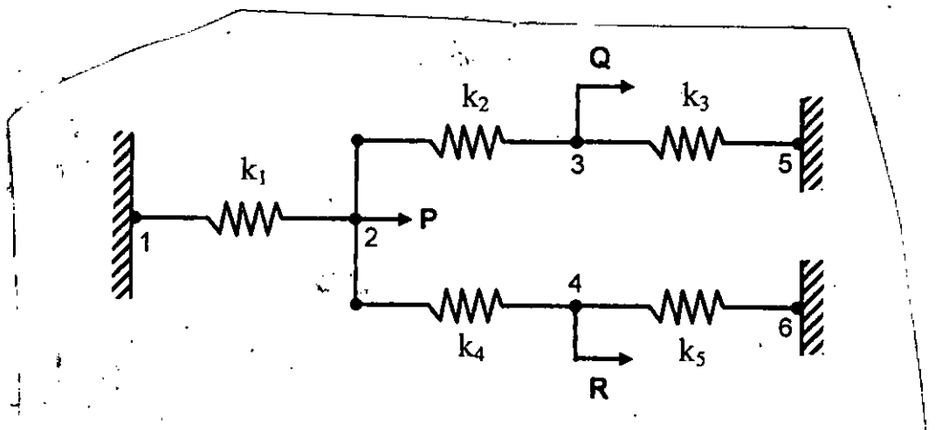


Figure Q3(b)

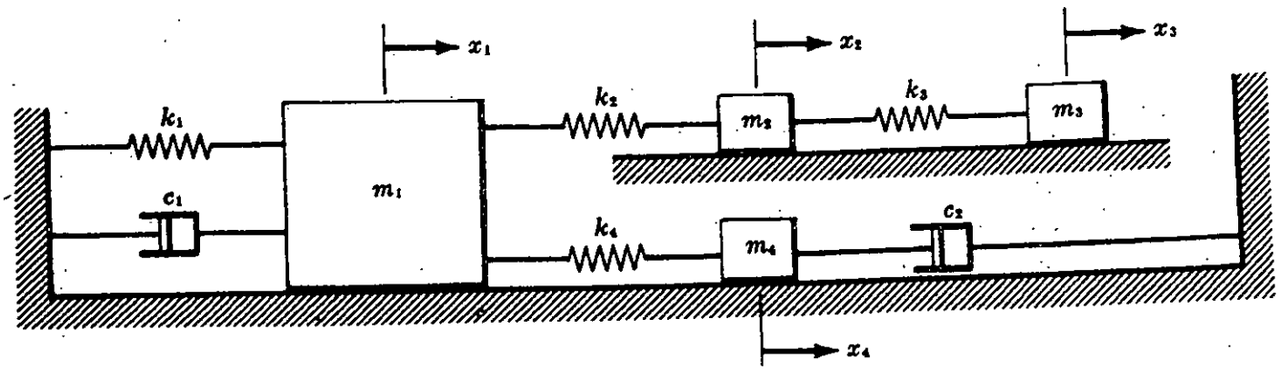


Figure Q4(a)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **ME 445** (Noise and Vibration)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Assume reasonable value of any missing data. Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Write the 1D governing equation of sound. Prove that it denotes a non-dispersive wave. **(10)**

   (b) Distinguish between sound power level and sound intensity level. **(5)**

   (c) List five points regarding the role of a noise control engineer. **(5)**

   (d) A point source of acoustic power 2 watt radiates uniform sound at 1 kHz. Assume freely propagating wave with no absorption loss. At a distance of 7 m from the source find: **(15)**

   (i) SPL and SIL (ii) sound pressure (iii) energy density (iv) the maximum particle velocity.

2. (a) A heavy duty compressor is to be installed in the machine room of an industry. Describe with necessary sketches all the standard steps for such an installation as far as noise and vibration control is concerned. **(17)**

   (b) Three sound sources # 1, # 2 and # 3 radiate sound at different frequencies that reaches a receiver (R) as shown in the FIGURE for Q. 2(b). Given: Source types. **(18)**

   # 1 point

   # 2 line/cylindrical

   # 3 plane wave

   Distances: # 1 to R = 60 m, # 2 to R = 50 m

   # 3 to R = 30 m

   # 1 to A = 20 m, # 2 to B = 15 m

   Take, $\alpha = 0.12$ dB/m.

   Calculate resultant SPL at R.

3. (a) Why is low frequency noise difficult to control? A 1.5 kHz sound source is 2 m high from the ground and horizontally 3 m to the left of a 4 m high vertical barrier. A receiver is horizontally 2 m to the right of the barrier and 1 m high from the ground. Assume the barrier to be perfect, Calculate the insertion loss due to it. Refer to FIGURE for Q. 3(a). **(14)**

   (b) With sketches describe the working principles of

   (i) a standard acoustic board,

   (ii) a reactive silencer and,

   (iii) a condenser microphone.

Contd P/2

ME 445

4. (a) Describe with sketches- **(10)**

(i) Duct noise control procedure in an HVAC system.

(ii) A standard sound measuring system.

(b) A random vibration signal with an ⅓ rd octave band has following data-

Central frequency = 2 kHz, x_{max} = +40 mm, x_{min} = –35 mm.

PSD is constant over Δf.

Calculate: (i) Expected value of x (ii) mean square value of x (iii) PSD.

List the necessary assumptions in random vibration analysis. **(12)**

(c) A room (10×8×2.5 m^3) has following data: **(13)**

$$\left.\begin{aligned}\alpha(\text{ceiling and floor}) &= 0.2\\ \alpha(\text{walls}) &= 0.1\end{aligned}\right\} \text{ at } 1.5 \text{ kHz.}$$

(i) Calculate the RT at 1.5 kHz.

(ii) A machine of acoustic power 'W' watt is turned on in the same room. A receiver, 5 m from the machine heards a sound of 77 dB. Knowing that the directivity factor is 3.6, calculate the 'W'.

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Find the expression of natural frequency of the system shown by figure for 5(a). If viscous damping is to be considered, what will be the change in the frequency of free vibration? **(15)**

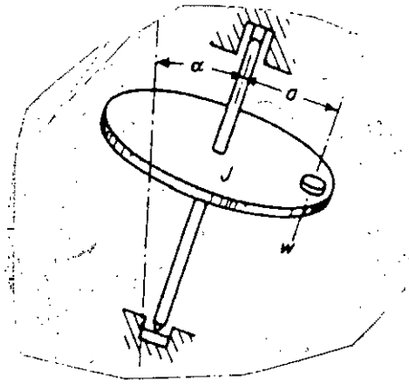


Figure for Q. No. 5(a)

(b) A 20 kg pump statically deflects by an amount of 25 mm on springs. Given, damping ratio, ζ = 0.10. If the resonant amplitude of the pump is 250 mm, find (i) the rotating unbalance and (ii) vibration amplitude when the pump runs at 1000 rpm. Also draw the mechanical impedance diagram corresponding to 1000 rpm. **(20)**

6. (a) A 10 kg pump statically deflects by an amount of 30 mm on springs. A disturbing force (F sinωt) acts on it. Vibration testing results show that damping ratio, ζ = 0.03, F = 10 N and ω = 10 rad/s.

L-4/T-1/ME

Date : 29/10/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B.Sc. Engineering Examinations 2018-2019

Sub : **ME 467**(Automobile Engineering)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

Abbreviations have their usual meaning.

1. (a) Briefly explain-why a tubeless tyre is less prone to failure compared to a tubed one? **(9)**

   (b) Distinguish between "Spare Tyre" and "Space-Saver Tyre". What do you understand by a "Tyre Mobility kit? **(10)**

   (c) What do you understand from tyre specification-180/70 R 16 S TWI. **(6)**

   (d) Distinguish between HYBRID and ELECRIC cars. Compare the typical fuel economy of HYBRID and regular versions of family sedan cars. **(10)**

2. (a) What do you understand by OBD? Briefly explain the various means by which a vehicle can express self-diagnosis for maintenance. **(12)**

   (b) Define A-h and CCR capacities of an automotive battery. Which one is more used in Bangladesh? **(7)**

   (c) Why is a solenoid used with a pre-engagement type starter motor? Briefly explain the role of "Over running clutch in protecting a starter motor. **(10)**

   (d) What is a TPS? Briefly explain its function. **(6)**

3. (a) What do you understand by "pitching" motion of a vehicle? Using simple mechanics explain why a vehicle pitches when brakes are applied. **(9)**

   (b) What do you understand by "Overturning Speed"? A car weighing 900 kg with only the driver is taking a right turn at a radius of 8.2 m. The vehicle has a wheel base of 2.5 m, track width of 1.7 m and the height of its CG is 0.75 m above road level. **(12)**

   (i) Calculate the maximum velocity in km/h to prevent overturning while taking this turn.

   (ii) How will this speed be affected if 3 passengers get on board?

   (c) Briefly explain how a compressor drive gets engaged when we put-ON the AC switch of a car. **(6)**

   (d) Briefly state the role of the T×V in car air conditioning system. **(8)**

4. (a) Distinguish between type-1 and type-2 CNG cylinders. List two safety devices recommended to be filled with a CNG cylinder of a car. **(9)**

   (b) Briefly explain the role of "STAP" in the performance of a CNG driven vehicle. **(9)**

   (c) Briefly state the steps of conversion of typical Diesel run buses to be retrofitted for CNG. **(10)**

   (d) What do you understand by "Single Wire" configuration used in automobile electrical system? What are its advantages? **(7)**

Contd P/2

ME 467

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

Assume any data if necessary. Symbols used have their usual meaning.

5. (a) With a block diagram show how power flows from the engine flywheel to the vehicle wheels in (i) a manual transmission RWD and (ii) an automatic transmission AWD vehicles. **(10)**

(b) In light of 5(a), explain why in case of a dead battery, a manual transmission vehicle can be push-started but an automatic transmission vehicle cannot be done so. What is the remedy for auto transmission vehicles in such case? **(10)**

(c) Comment on the relative merits and demerits of manual transmission and auto transmission systems considering the following features: control, vehicle cost, fuel economy, maintenance, efficiency, traffic condition, feeling, weight and cooling. **(9)**

(d) List the major components of an automatic transmission system vehicle. Also show the typical gear positions in an automatic transmission system? **(6)**

6. (a) What are the gear ratios used in a typical steering system? **(4)**

(b) Make a comparison between hydraulic power steering and electrical power steering systems. **(6)**

(c) Show how the four wheels turn in a four-wheel steering system when steering at low speed and at high speed. **(5)**

(d) With sketches show the different parameters which effect 'front-end geometry' of a vehicle. Why are camber and caster used? **(20)**

7. (a) List the driver factors, vehicle factors, vehicle factors and environmental factors which influence the typical stopping distance of a vehicle during braking. **(9)**

(b) Make a comparison between disc brakes and drum brakes on the basis of their construction, effectiveness of braking, cost and maintenance. **(10)**

(c) Draw the layout of a typical dual braking circuit of a vehicle having disc brakes at the front and drum brakes at the rear. **(6)**

(d) With a schematic, describe how a vacuum-assisted braking system works. **(10)**

8. (a) List the purposes of a suspension system in a vehicle. **(4)**

(b) Define 'sprung weight' and unsprung weight' of a vehicle. How do they effect the vehicle stability and comfort during rides? **(10)**

(c) With appropriate sketches describe a Macpherson-strut type front suspension system. **(12)**

(d) What do you understand by 'semi-active' and 'active' suspension systems? – Briefly explain. **(9)**
