L-4/T-1/ME **Date : 03/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols indicate their usual meaning. Assume any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Briefly explain the phases of CI engine combustion. **(10)**

   (b) Briefly explain the knocking mechanism in SIE. Explain the measures to reduce knock in SIE. **(10)**

   (c) Explain the physical interpretations of the following terms:

   (i) LHV (ii) SIT (iii) Laminar brining velocity. **(15)**

2. (a) Explain the reasons for opening the values earlier and closing later. Also, explain the effects of engine speed on valve timing. **(10)**

   (b) Briefly explain the similitude principle applied in air systems design. Give an example to show how the effects of 'coolant temperature' are addressed. **(10)**

   (c) Explain the detailed reasoning (based on heat transfer and fluid flow) for making exhaust valves smaller. Also, present the equations for valve sizing. **(15)**

3. (a) Present ideal and actual p-v diagrams of SI engines. Explain the reasons for their differences. **(10)**

   (b) Write short notes on engine turbocharging and supercharging. **(10)**

   (c) For engines, show that:

$$bmep = \eta_i \eta_c \eta_v \eta_m \left(\rho_a \left(\frac{F}{A} \right) Q_{LHV} \right).$$

   Explain the physical meaning of 'bmep' and the efficiency terms present at the above equation. **(15)**

4. (a) Estimate typical output power of a SI engine of 1500 c.c. size, running at 5000 rpm and using methane as fuel. **(10)**

   (b) Briefly explain the effects of ambient parameters on engine output power and fuel consumption. **(10)**

   (c) Briefly mention the practical reasoning for the following statements: **(15)**

   (i) SI engine rpm is high. (ii) knock increases with engine speed in CI engine.

   (iii) Slightly higher brake power is available for slightly rich air-fuel mixtures.

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SECTION – B

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

5. (a) List two advantages of a two-stroke cycle engine over a four-stroke cycle engine. List two advantages of a four-stroke cycle engine over a two-strike cycle engine. **(8)**

   (b) What is meant by mean piston speed? Explain its importance. **(6)**

   (c) A five-cylinder, 3.5-liter SI engine operations on a four-stroke cycle at 2500 RPM. At this condition, the mechanical efficiency of the engine is 62% and 1000 J of indicated work are produced in each cycle in each cylinder.

   Calculate: **(21)**

   (i) Indicated mean effective pressure

   (ii) Brake mean effective pressure

   (iii) Friction mean effective pressure

   (iv) Brake power in kW and hp.

   (v) Torque

6. (a) Give three reasons why methanol is a good alternate fuel for automobiles. Give three reasons why it is not a good alternate fuel. **(6)**

   (b) A flexible-fuel vehicle operates with a stoichiometric fuel mixture of one-third isooctane, one-third ethanol, and one-third methanol, by mass. Calculate: **(20)**

   (i) Air-fuel ratio.

   (ii) MON, RON, FS, and AKI.

   (c) A modern six-cylinder automobile CI engine is adjusted to operate properly using diesel fuel with a cetane number of 52. The vehicle is accidentally fueled with a diesel fuel having a cetane number of 42. Would more or less exhaust smoke be expected? Explain. **(9)**

7. (a) Why isn't a normal three-way catalytic converter, as used with SI engines, as useful when used with a CI engine? What is the main method used to limit NOx emissions on a modern diesel truck or automobile? Give at least three disadvantages to using this method. **(11)**

   (b) Draw schematic diagram of a fuel feed pump and explain its working principle. **(15)**

   (c) As speed increases in an engine with throttle body fuel infection, does the temperature of the air-fuel mixture at the intake manifold exit increase or decrease? Explain what parameters affect your answer. **(9)**

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8. (a) Explain the basic principle and working of hydraulic dynamometer. **(12)**

   (b) Explain the principle of measurement of un-burnt HC from engine exhaust. **(10)**

   (c) What are the various components to be lubricated in an engine and explain how it is accomplished? **(9)**

   (d) What are the limitations of liquid cooling system in an IC engine? **(4)**

L-4/T-1/ME **Date : 12/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Assume reasonable value for missing data. 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) State and explain the dynamic action of fluid. Derive an expression of efficiency for a series of curved vanes fitted on the periphery of a rotating wheel. **(17)**

   (b) A 2.5 cm diameter jet with a velocity of 70 m/s strikes, without shock, on a series of vanes which moves in the same direction as the jet. The shape of vane is such that when stationary it would deflect the jet through an angle of 160°. If the relative velocity is reduced by 10% due to friction and there is a windage loss of $\frac{u^2}{2g}$ kg. m/kg of water, determine (i) The velocity of vanes corresponding to the maximum efficiency, (ii) The corresponding force on the vanes and its direction. Here "u" is the velocity of vanes. **(18)**

2. (a) Draw the schematic diagram of a pelton turbine showing all the components and briefly describe the working proportions related to the components. **(17)**

   (b) A 1350 m long pipe is connected to three different single jet pelton turbine. The head of water is 410 m and the speed of each turbine is 600 rpm. The coefficient of velocity for the nozzle is 0.97 and the friction factor for the pipe is 0.025. For each turbine, specific speed is 20 and the overall efficiency is 86%. If the head loss due to friction in pipe is 15 m of water, find (i) total power delivered, (ii) flow rate, (iii) nozzle and pipe diameters. **(18)**

3. (a) Describe the functions of (i) draft tube and (ii) surge tank used in hydraulic turbine. **(8)**

   (b) Derive the expressions of "unit speed" and "unit power" from the concept of unit turbine. **(10)**

   (c) An inward flow reaction turbine is supplied with 100 cumec of water under an effective head of 150 m. The diameter at the inlet and outlet are 3.5 m and 2.5 m, respectively. If the inlet vane angle is 120°, the hydraulic efficiency is 85% and the discharge is radial with a velocity of 15 m/s, find the power developed and the speed of the runner. Also calculate the breadth ratio and speed ratio. Assume the breadth of the runner as constant. **(17)**

Contd P/2

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4. (a) What is fluid coupling? Describe its working principle with neat sketches. **(10)**

   (b) Explain the performance of a torque converter and write the differences with that of fluid coupling. **(10)**

   (c) A Kaplan turbine has an outer diameter of 6.2 m and hub diameter of 2.0 m. The hydraulic and mechanical efficiencies of the turbine are 85% and 90%, respectively. If the flow rate of water is 180 m^3/s, find the output power and the head of water, Neglect the velocity of whirl at outlet. **(15)**

SECTION – B

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

5. (a) Explain, in brief, the operating mechanisms by which the pressure of fluids is raised in centrifugal pumps and positive displacement pumps. **(6)**

   (b) What are the functions the casing play in the operation of a centrifugal pump? Discuss, in brief, different types of casing of centrifugal pumps. **(9)**

   (c) What is zero suction head? In what circumstances is zero suction head recommended for the installation of a centrifugal pump? **(6)**

   (d) Water is transported from tank A to tank B by a pump. The dimensions of the system are shown in the figure for Q. 5(d).

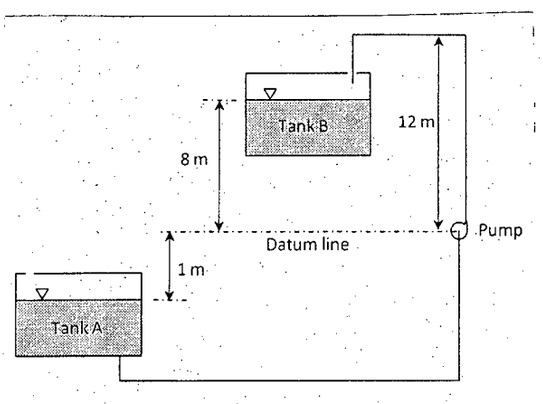

Figure for Q5.d

   The total lengths of the suction pipe and the delivery pipe are 30 m and 20 m, respectively. The total head losses in the suction pipe and the delivery pipe are 1 m and 0.5 m, respectively. Find the water power the pump needs to deliver if the flow rate is 10 liter per sec. Neglect the velocity head. **(14)**

6. (a) Starting from the Euler head, derive an expression for the theoretical head-discharge relation in a centrifugal pump. What is shut-off head? **(10)**

Contd P/3

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Contd ... Q. No. 6

(b) With the help of necessary velocity diagrams, explain the reason of the losses of head if the pump discharge deviates from the design point. **(8)**

(c) Establish a relation for the minimum starting speed of a centrifugal pump in terms of its geometry and the manometric head. **(8)**

(d) The linear scale ratio of the model and the prototype of a centrifugal pump is 1:4. The prototype delivers 1550 liter per sec of water at 550 rpm against a head of 31 m and consumes 750 kW. If the model works against a head of 11 m, find the speed, discharge and power required by the model. **(9)**

7. (a) Derive an expression of the actual power input for a single-acting reciprocating pump. **(10)**

(b) A single-acting reciprocating pump discharges 0.018 m^3 per sec of water when running at 60 rpm. The pump has 500 mm stroke length and 220 mm piston diameter. If the total lift is 16 m, find **(12)**

(i) theoretical discharge of the pump

(ii) slip and percentage slip of the pump

(iii) coefficient of discharge

(iv) theoretical power required for running the pump.

(c) A single-acting reciprocating pump has the following characteristics. Cylinder diameter = 120 mm, stroke = 300 mm, suction head = 2.5 m, suction pipe diameter = 75 mm and suction pipe length = 10 m. If the pump runs at 30 rpm find **(13)**

(i) the maximum acceleration head

(ii) the pressure head in the cylinder at the beginning of the stroke

(iii) the maximum speed at which the pump can be run avoiding cavitation.

Assume total frictional losses = 0.5 m and vapor pressure of water = 2.6 m water (abs).

8. (a) Considering that the piston velocity of a single-acting reciprocating pump is given by, $v = \omega r \sin\theta$, show that the frictional head loss in the suction and delivery pipes is parabolic and the maximum frictional head loss occurs at the middle of the stroke. **(10)**

(b) What is indicator diagram? Draw the actual indicator diagram and identify different components of pressure head. **(10)**

(c) Estimate the savings in work against friction when an air vessel is attached to a single acting reciprocating pump. **(10)**

(d) What are the differences in the characteristics of a propeller pump and a Kaplan pump? **(5)**

L-4/T-1/ME **Date : 18/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

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 meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Define refrigeration system. With a schematic diagram show the key components of a refrigeration system. What are the applications of refrigeration system? **(15)**

   (b) A fish freezing plant uses two stage compression refrigeration systems with inter-cooling and removal of flash gas. Calculate the power required by the two compressors if the refrigerant is R-134a which serves a 60 kW evaporator at -40°C and 70 kW evaporator at –20°C. The condensing temperature is 34°C and the intercooler temperature is –20°C. Draw the schematic diagram and P-h diagram of the system. Also calculate the COP of the system. **(20)**

2. (a) What are the differences between refrigeration and air conditioning system? Why the outdoor air is required in air conditioning system? What are the basic differences between all air system and all water system? **(15)**

   (b) Air enters a split air conditioner at 1 atm., 32°C, and 80 percent relative humidity at a rate of 15 m^3/min. The air leaves the cooling section as saturated air at 14°C. Part of the moisture in the air that condenses during the process is also removed at 14°C. Determine the rate of heat transfer and moisture removal from the air. **(20)**

3. (a) What is fire? What are the effects of fire? Briefly describe the sprinkler fire protection system with schematic diagram. **(20)**

   (b) For a facility having building of light hazard-I type, 30 rentable floors, each 2500 m^2 net. Floor-to-floor height = 3.7 m. According to BNBC determine the storage capacity of water for fire protection for that building. Draw the typical diagram for fire protection system with different water supply zones with ground and gravity roof tank with adequate domestic and fire reserve for a tall building (according to BNBC). **(15)**

4. (a) What are the requirements for the ideal performance of passenger elevators? **(10)**

   (b) Define Interval (I) time, Handling capacity (HC) and Round Trip (RT) time for elevator. For an office building, downtown, diversified use, 18 rentable floors above the lobby, each 3000 m^2 net, floor-to-floor height = 3.7 m, determine a working elevator system arrangement. **(25)**

Contd P/2

ME 415

SECTION – B

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

Refrigeration and A/c Data book will be provided.

5. (a) What are the different types of compressors used in refrigeration systems? Describe the working principle of rotary sliding vane type compressor. **(17)**

   (b) Describe with neat sketches a counter-flow forced draft evaporative condenser. What are the benefits of using forced draft condenser? **(18)**

6. (a) What are the benefits of electronics expansion valve (EXV) used in a refrigeration system? Also explain how its control system works. Describe with necessary diagram. **(17)**

   (b) Describe the Linde liquefaction plant for liquefying gas with neat sketch. Draw the necessary T-s diagram. Explain the necessity for using two heat exchangers in this process. **(18)**

7. (a) Describe with neat sketch the working principle of magnetic refrigeration. Explain how so low temperature like absolute zero can be achieved by this refrigeration process? **(17)**

   (b) Describe air-craft cooling system. Justify the statement in regard to air-craft cooling "Though the outside temperature is very low at high altitude, still cooling of cabin is required for air-craft." **(18)**

8. Estimate the cooling load of an office room at 4 pm for the following conditions:

Location	: Chittagong
Date	: 15 May
Floor	: 9 m × 9 m, Height 3.8 m
Roof	: Type 4, 100 mm concrete with 50 mm insulation
Walls	: 100 mm face brick + 100 mm common brick (Type –D)
Window	: 18% of wall area, 12.5 m clear glass, U = 2.8 $W/m^{2o}C$
Light	: 13 W/m^2, fluorescent bulb

9 people using 3 computers @ 90 W. Assume negligible heat transfer through south and east walls. Also assume ASHRAE standard in door design conditions and ventilation air supply. **(35)**

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	60–80	36–48
Hotels—first quality	30–50	18–30
Hotels—second quality	50–70	30–42

T2: Minimum PHC

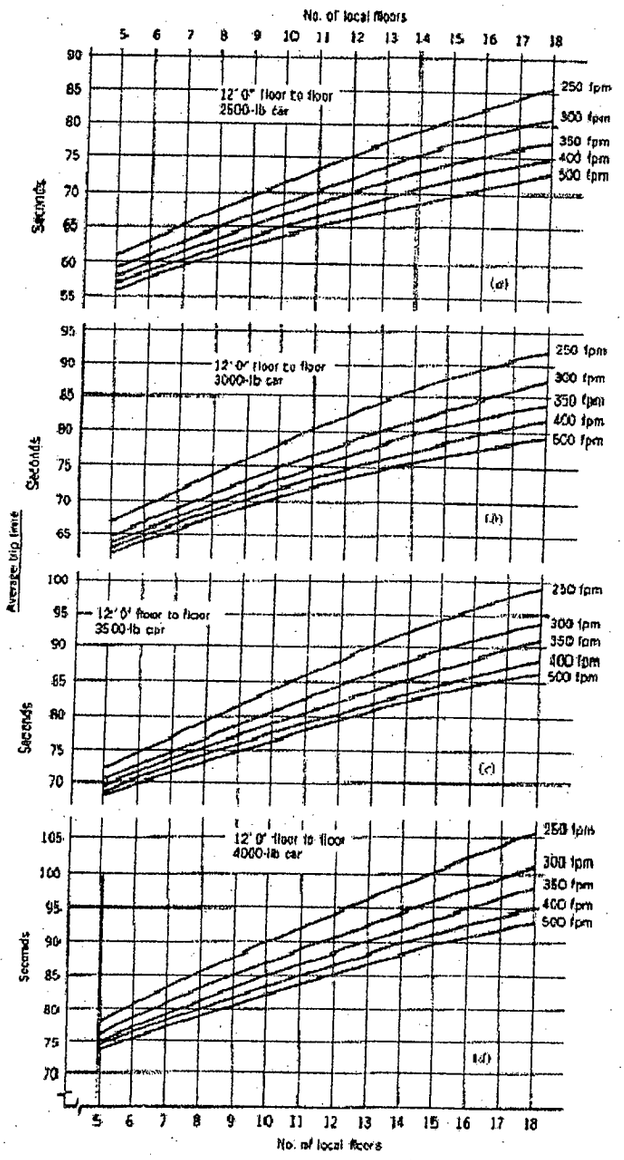
Facility	Percent of Population to Be Carried in 5 Minutes
OFFICE BUILDINGS	
Center city	12–14
Investment	11.5–13
Single-purpose	14–16
RESIDENTIAL	
Prestige	5–7
Other	6–8[a]
Dormitories	10–11
Hotels—first quality	12–15
Hotels—second quality	10–12

e919

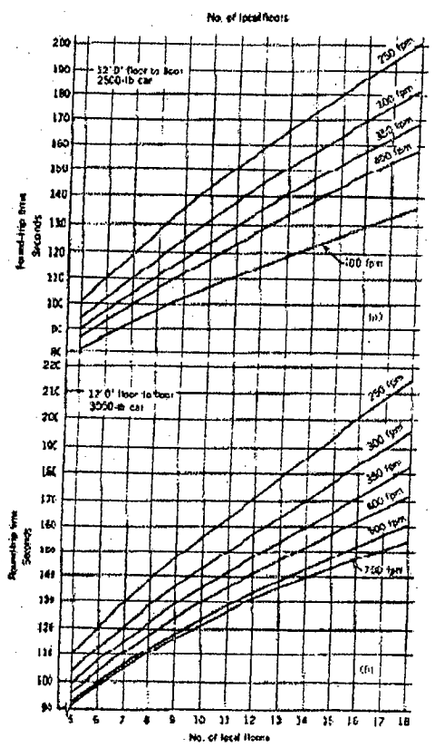
T3: Car Passenger Capacity (p)

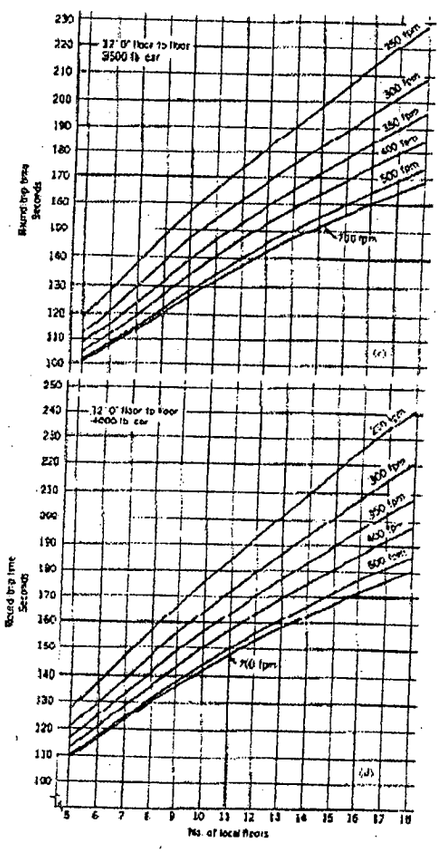
Elevator Capacity lb (kg)	Maximum Passenger Capacity	Normal Passenger[a] Load per Trip
2000 (907)	12	10
2500 (1134)	17	13
3000 (1361)	20	16
3500 (1588)	23	19
4000 (1814)	28	22

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%

e922

T6: Elevator Equipment Recommendations

	Car Capacity		Rise		Minimum Car Speed	
Building Type	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	3500	1600	0–60	0–20	150	0.63
			61–100	21–30	200–250	1.0
	4000	2000	101–125	31–40	250–300	1.6
			126–175	41–55	350–400	2.0
			176–250	56–75	500–600	2.5
			>250	>75	700	3.6
Apartments	2000	1000	0–75	0–25	100	0.63
			76–125	26–40	200	1.0
	2500	1250	126–200	41–60	250–300	1.6
			>200	>60	350–400	2.0
Stores	3500	1600	0–100	0–30	200	1.0
			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

L-4/T-1/ME **Date : 24/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

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) What do you understand by a "Maintenance Free" automotive battery? Briefly explain how can we check the charge condition of such a battery. **(9)**

   (b) What do you understand by the following battery specification – 90 A-h, 72 Plate, 12 V. **(6)**

   (c) What is a TXV? Briefly explain its role in an automobile air conditioning system. **(10)**

   (d) How can you distinguish between the condenser of an air conditioning system and the radiator of the engine cooling system of a car? Briefly explain. **(10)**

2. (a) What is a SRS Airbag? Briefly explain how a driver's airbag works. **(11)**

   (b) How can you identify a tubeless tyre? What are the advantages of using tube less tyres? Can a tubeless tyre still be used if only the wheel rim is damaged? **(11)**

   (c) A tyre is designated as– 210/70 R 15 H TWI. What do you understand from the specification? **(6)**

   (d) What do you understand by "Single Wire" configuration used in automotive electric layout. Why is it used? **(7)**

3. (a) What is an 'Oxygen sensor"? Briefly explain how does it control the engine operation. **(11)**

   (b) Is it possible to run a SI engine on CNG without a STAP? Briefly explain which aspects of vehicle performance are improved when STAP is used and why? **(12)**

   (c) How can you distinguish between Type-1 and Type-2 CNG cylinders? Which type is more common in Bangladesh and why? **(8)**

   (d) List the safety devices needed to be fitted with a CNG storage cylinder. **(4)**

4. (a) What do you understand by OBD system? Briefly explain how can it be more informative compared to MIL system provided on the dash-board. **(11)**

   (b) Briefly discuss the main forces influencing vehicle motion when a car is coming down a flyover. What limits the maximum speed of a car running on a flat straight road? Briefly explain. **(12)**

   (c) What do you understand by "Overturning Speed"? Deduce expressions for "Overturning" and "Skidding" speeds for taking a turn on a flat curved road. **(12)**

Contd P/2

ME 467

SECTION – B

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

5. (a) With neat sketch(es), describe the working principle of a synchronizer in a synchromesh transmission system. **(15)**

   (b) Why are differentials used in automobiles? Discuss, with a neat sketch, the construction and operation of a limited-slip differential. **(20)**

6. (a) Discuss the effects of camber, caster, steering-axis inclination, and toe angle on the driveability of an automobile. Show them in diagrams with their effects on tyre wear. **(15)**

   (b) List the different types of automotive suspension system. Draw and explain the operation of a torsion-bar suspension system. **(20)**

7. (a) What is meant by dual-braking system? With a neat sketch, describe the construction of the master cylinder of a dual-breaking system. **(15)**

   (b) Why are disc brakes used on front wheels and drum brakes on rear wheels in light/medium automobile vehicles? Discuss, with a necessary sketch, the operation of a fixed-caliper disc brake. **(20)**

8. (a) What are the uses of constant-velocity (CV) universal joints in the front-axle of a FWD vehicle? Discuss the construction and the principle of operation of a Rzeppa CV joint. **(15)**

   (b) Write short notes on: **(20)**

   (i) Automatic- and manual-transmission systems

   (ii) FWD and RWD

   (iii) Clutch friction disc

   (iv) Automotive steering System.

L-4/T-1/ME **Date : 24/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meanings and significance. Reasonably assume any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) With a neat sketch describe the working principle of a dynamic microphone. **(6)**

   (b) Distinguish between- **(9)**

   (i) A piezoelectric accelerometer and a condenser microphone.

   (ii) sound power level and sound pressure level.

   (iii) sound reflection and sound diffraction.

   (c) The central frequency (f_c) is 1200 Hz for an $\frac{1}{3}$rd octave band signal. Given, PBL = 110 dB. Find (i) Δf (ii) PSL and spectral density function at f_c (iii) $\bar{\varepsilon}$ corresponding to PBL (iv) $\bar{\varepsilon}$ corresponding to PSL at f_c. Take α = 0.1 dB/m. **(20)**

2. (a) Define following terms with necessary equations and figures: **(10)**

   (i) Acoustic impedance (ii) Acoustic mufflers.

   (b) How is sound absorbed by some porous materials? List 4 sound absorbing materials. **(5)**

   (c) A receiver (R) receives sound from a point source that is 30 m away and also from a plane wave source that is 3 m away. When the point source is off, SPL at R is 90 dB and when the plane wave source is off, SPL at R is 80 dB. Given, α = 0.1 dB/m. Find (i) SPL and X at R when both sources are ON. Take, f = 1 kHz. (ii) Sound power level of the point source and the plane wave source. **(20)**

3. (a) Describe with sketches, the working principle of (i) an acoustic board (ii) sound trap. **(10)**

   (b) A heavy duty pump 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. **(15)**

   (c) With sketches describe the mechanism of controlling duct noise and pipe noise of an HVAC system. **(10)**

4. (a) A room ($10 \times 8 \times 2$ m^3) has following data: **(15)**

$$\left.\begin{aligned} \alpha\ (\text{celing and floor}) &= 0.2 \\ \alpha\ (\text{walls}) &= 0.15 \end{aligned}\right\} \text{ at } 1\ kHz$$

ME 445
Contd ... Q. No. 4(a)

(i) Calculate RT of the room at 1 kHz.

(ii) A machine of acoustic power 0.025 Watt is turned on in the same room. A receiver, 4 m from the machine, has a directivity factor of 2.5. Calculator SPL at the receiver.

(b) "Noise and vibration are mutually convertible" – explain with an example. **(5)**

(c) Starting from the governing equation of motion for axial vibration of a fixed-free rod, determine the first three natural frequencies. **(15)**

SECTION – B

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

5. (a) An engine valve system operated by push rod rocker arm is shown in Fig. 5(a). The mass moment of inertia of the rocker about its axis is I, the masses of valve and push rod are m, and m_p, respectively. The valve spring stiffness is K_s and its mass is m_s. The push rod can be replaced by a spring of equivalent stiffness K_p. Determine the natural frequency of the system considering the rocker and valve to be rigid. **(15)**

(b) Two masses m_1 and m_2 are attached to a rigid weightless bar which is supported by springs of stiffness k_1 and k_2 and a dashpot of damping coefficient c as shown in Fig. 5(b). If the motion of the bar is restricted to the plane of paper, determine the equations of motion of the system by the use of Lagrange's equation. **(20)**

6. (a) Plot MX/me versus ω/ω_n curve for a SDOF having rotating unbalance. Mathematically prove that MX/me approaches unity for large value of ω/ω_n. **(10)**

(b) For a SDOF system, having harmonically excited vibrations, following data is given: m = 200 kg, K = 2 MN/m, damping ratio= 0.5. Draw the system, mechanical impedance diagram and write the governing equation. Find magnitude of the impressed force if X = 0.01 m at ω = 600 rpm. Next, find the transmitted force. Also draw TR versus β curve to show where vibration isolation is possible. **(20)**

(c) With neat sketch, describe the working principle of a velometer. **(5)**

7. (a) Sketch a Lanchester damper. Why is optimum tension in the bolt important in this damper? Draw speed versus time for it and hence write the expression for energy dissipated per cycle. **(10)**

(b) Sketch and label a Houdaille damper. Also plot $k\theta_0/M$ versus speed ratio (β) curve for different damping ratio (ξ). Hence, write the significance of the optimum damping ratio. **(10)**

Contd P/3

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Contd ... Q. No. 7

(c) A centrifugal absorber has following data:
Exciting frequency = 750 rad/s when the shaft runs at 100 rad/s.
Wheel radius, R = 150 mm.
Find absorber radius (r) to make the shaft vibration zero. If absorber mass is 0.1 kg and its amplitude is $\pi/4$, estimate the exciting torque. **(15)**

8. (a) A 10 kg pump vibrates violently when runs at an operating speed of 1000 rpm. A tuned absorber of mass 2 kg is attached to cut down the pump's vibration to zero. However, the absorber itself vibrates with an amplitude of 10 mm. Find (i) absorber stiffness (ii) magnitude of the disturbing force acting on the pump. **(15)**

(b) Using appropriate boundary conditions and starting from the fourth order differential equation of beam deflection, derive the expression of the first three natural frequencies for a both end fixed beam. **(20)**

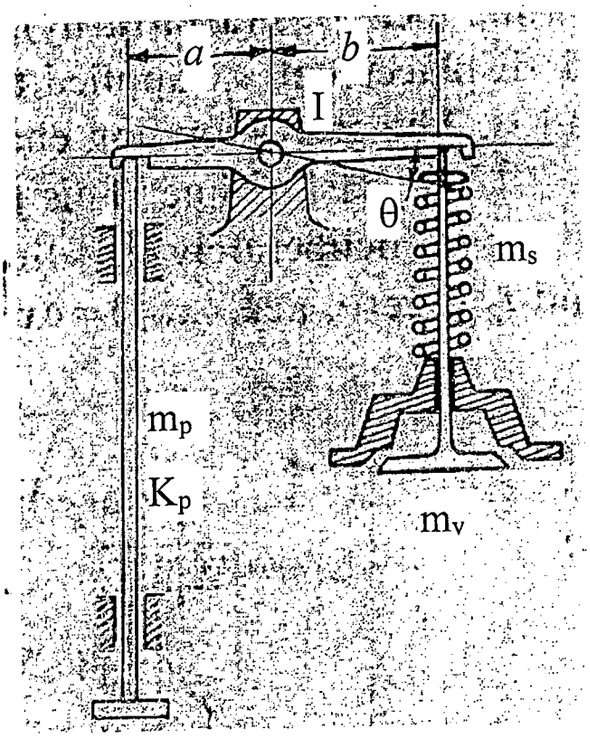

Fig. 5(a)

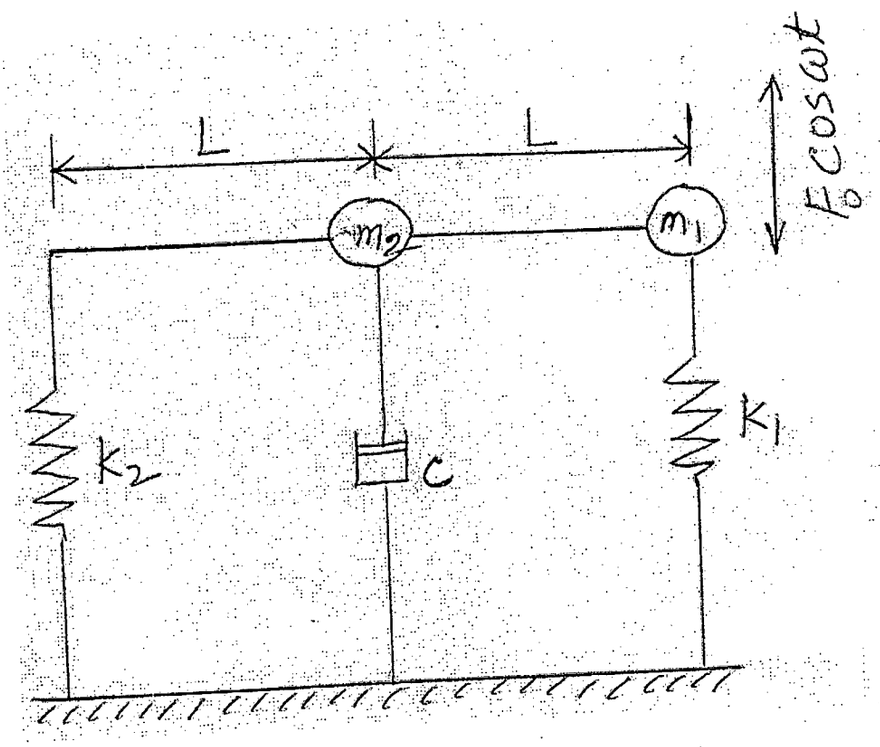

Fig. 5(b)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

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) Give a neat sketch to show all possible stress resultants and couples acting at the edges of a thin plate.

   For thin plate bending, show that shear forces can be expressed in terms of moment components as follows: **(18)**

$$V_x = \frac{\partial Mx}{\partial x} + \frac{\partial Myx}{\partial y}$$

$$Vy = \frac{\partial My}{\partial y} + \frac{\partial Myx}{\partial x}$$

   (b) With neat sketches, describe the details of governing differential equation and the respective boundary conditions for the following structural problems: **(17)**

   (i) a thin cantilever plate subjected to a uniform pressure

   (ii) a guided cantilever beam under a triangularly distributed pressure is resting on an elastic foundation.

2. A thin square plate having sides of unit length is simply supported along its edges and carries a uniformly distributed load of unit intensity. Showing all mathematical details, determine the deflected form of the plate in terms of a double trigonometric infinite series and also find the corresponding distributions of bending and twisting moments.

   Find the maximum deflection and moments in the plate. **(35)**

3. (a) State and explain the mathematical details of Minimum Potential Energy method for structural analysis.

   Demonstrate the application of the method for a beam with various types of loading. **(17)**

   (b) For the spring system shown in Fig. for Q. 3(b), determine the following by Potential Energy Method. **(18)**

   (i) displacement at the junction nodes

   (ii) individual spring forces

   (iii) reactions at the supports

Contd P/2

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Contd ... Q. No. 3(b)

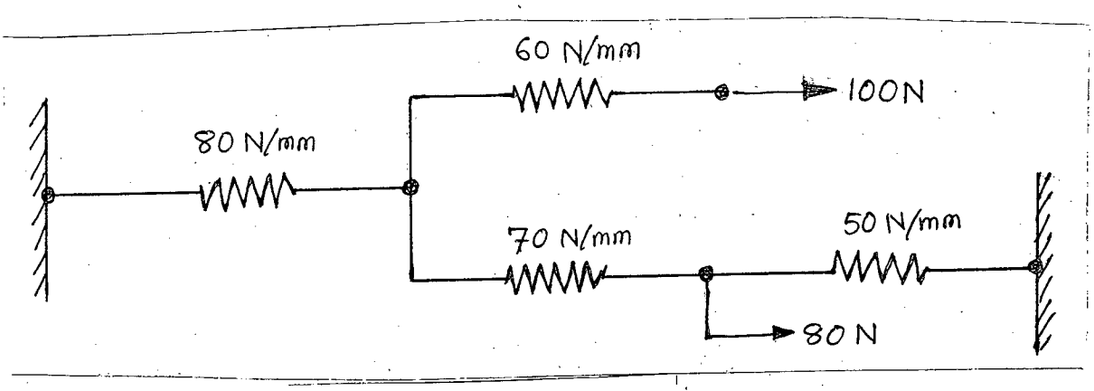

Figure for Q 3(b)

4. (a) Determine the equations of motion for the vibratory spring-mass system shown in Fig. for Q. 4(a) using Lagrange's energy approach.

Expressing the equations by a single matrix equation, determine the inertia matrix, stiffness matrix, and dynamic matrix for the system. For small angle oscillations, the motions in perpendicular directions may be taken independent of each other. **(20)**

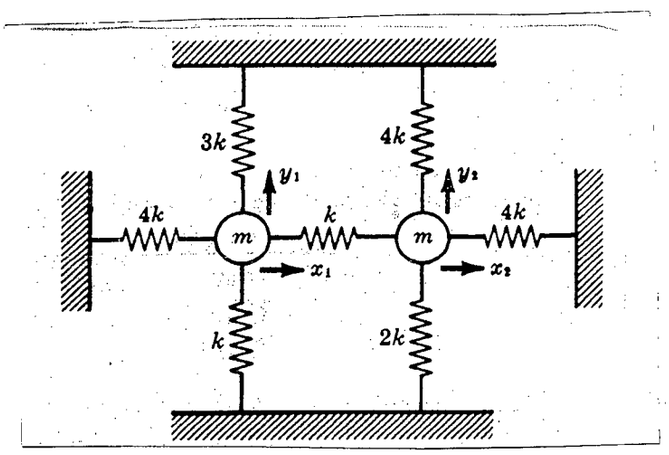

Fig. for Q. 4(a)

(b) Discuss the use of elastic supports at the ends of beams. Show that the conventional supports used for beams are the limiting cases of elastic supports. **(15)**

SECTION – B

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

5. (a) With appropriate sign convension draw a 3-D element showing 9-stress components. **(5)**

(b) Derive the 3-D stress-strain relations in terms of Lame's constant λ and shear modulus G. **(15)**

(c) The displacement field of a deformed elastic body is given by. **(15)**

$$u = (2x + 5xy^2 + 5z) \times 10^{-5}m$$

$$v = (3x + yz) \times 10^{-5}m$$

$$w = (xz^2) \times 10^{-5}m$$

Find the state of stress at point (2, 5, 1) within the body if G = 80 GPa and λ = 115 GPa.

Contd P/3

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6. (a) Show that the change in volume of a cube due to uniform axial tensile stress σ is given by

$$\Delta V = \frac{1}{E}(1-2\mu)\sigma V_o$$

where the symbols have their usual meaning. **(20)**

(b) A 25 m long steel rod of diameter 25 mm is suspended vertically from a crane. Find the change in volume due to self weight if density of steel is 7700 kg/m^3 and E = 200 GPa. **(15)**

7. (a) Derive the differential equations for static equilibrium of a 3-D elastic body having external and body forces. **(18)**

(b) Consider a stress field as

$$\sigma_{xx} = 50x^3 + 2y \text{ MPa}$$
$$\sigma_{yy} = 40x^3 + 500 \text{ MPa}$$
$$\sigma_{zz} = 60y^2 + 30z^3 \text{ MPa}$$
$$\tau_{xy} = 100z + 80y^2 \text{ MPa}$$
$$\tau_{yz} = 0$$
$$\tau_{zx} = xz^3 + 40x^2y \text{ MPa}$$

Find the body force distribution required to maintain equilibrium. Find also the components of body force at point (2, 2, 1). **(17)**

8. (a) Determine the stress distribution in a solid bar of elliptic cross-section, subjected to uniform torque T. **(18)**

(b) Derive the governing equation for warping function formulation and find an expression for the torsional constant J in terms of stress function. **(17)**

L-4/T-1/ME **Date : 30/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

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) Why is stepped regulation of speed and feed commonly used in traditional machine tools? What are the laws of stepped regulation? Which law is the best among those? Give proper reasoning behind your selection. **(10)**

   (b) What are structural diagrams? Mention the criteria for selecting the best structural diagram. **(10)**

   (c) A lathe is designed for machining aluminium workpiece of up to 500 mm diameter and mild steel workpiece of upto 300 mm diameter. Both HSS and cemented carbide tools are used. Determine the diameter of the smallest workpiece which maybe machined on this lathe if the permissible cutting speed of the HSS-mild steel pair = 50 m/min, that of the carbide-aluminium pair = 1500 m/min and $R_n = 75$. **(10)**

   (d) Prove that, the number of teeth of adjacent gears must differ by at least four to avoid collision between gears. **(5)**

2. (a) What is feedback control in machine tool? Discuss the guidelines of designing machine tool elements based on anthropometric data and ergonomics. **(10)**

   (b) Why are the clearances between slideways components required to be adjusted? Explain the mechanism of clearance adjustment in dovetail slideways with suitable diagrams. **(10)**

   (c) Explain the design of slideways for wear resistance by analyzing the forces acting upon the slideways surfaces. **(15)**

3. (a) Explain the advantages of using diamond pin locators over round head pins while locating an object with multiple holes with suitable diagrams. **(10)**

   (b) Which workpiece holding device could be used for drilling holes in components having irregular shapes? Explain with suitable diagram. **(10)**

   (c) What is 3-2-1locating principle? Discuss how all the motions of an object can be eliminated using six pins and a clamp. **(10)**

   (d) Briefly explain the effect of holes on the rigidity of a machine tool structure. **(5)**

Contd P/2

IPE 431(ME)

4. (a) Explain the working principle of infinitely variable hydraulic drive. What are the advantages and disadvantages of using such drive? **(10)**

   (b) Discuss the working principle of a gear pump with suitable diagram. How can you calculate the theoretical flow rate and power requirements of a gear pump? **(10)**

   (c) Explain the working principle of the following variators using suitable diagrams: **(15)**

   (i) Svetozarov variator (ii) Wulfel Kopp Tourator

SECTION – B

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

5. (a) Why does the feed gear box of engine lathe designed for only standard threads? Describe the location and purposes of change gears in lathe machine. **(8)**

   (b) What are the locations and purposes of half nut and worm gearing in feed drive of an engine lathe? **(9)**

   (c) In which taper tuning method do you need to disengage the feeding screw of cross slide? Discuss the method in detail with necessary sketches. **(9)**

   (d) What are the functions of the clutches in the gear train of certain engine lathe? Mention specifically at least three locations of clutches in gear train of an engine lathe. **(9)**

6. (a) What are the main features of scroll plate? How does it help all the jaws to move on unison? Explain briefly. **(8)**

   (b) Where do you exactly set the follower rest in a lathe machine? Explain the purposes of follower rest. **(9)**

   (c) What are the purposes of spacer in arbor? Explain briefly. What are the purposes of fly-cutting process? **(9)**

   (d) Why does the index plate rotate during differential indexing? Discuss the mechanism related to rotation of index plate. **(9)**

7. (a) Discuss the features of multiple-tool shaping cutter head. **(10)**

   (b) What are the motions involved in gear shaper? Explain them briefly. **(12)**

   (c) What are the motions involved and cutter setting mechanism for cutting helical gear in gear hobber? Explain with necessary sketches. **(13)**

8. (a) What is strain back effect? How does it affect the cutting tool? How does the clapper box save the cutting tool? **(12)**

   (b) What do you mean by pre-loading of bearing? How does pre-loading of bearing increase the machining accuracy? **(13)**

   (c) Discuss the different acceptance tests in details. **(10)**