L-4/T-1/ME **Date : 14/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2021-2022

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 used have their usual meaning and interpretation.

Refrigeration and A/C Data Book will be provided.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What are the basic characteristics of quick freezing process? Classify quick freezing process. Briefly describe the Plate Freezing process with schematic diagram. **(15)**

   (b) Calculate the power required by the two compressors in a R134a system which serves a 80 TR evaporator at –40°C and 100 TR evaporator at –10°C. The system uses two stage compressions with inter-cooling and removal of flash gas. The condensing temperature is 30°C and the intercooler temperature is –10°C. Draw the schematic diagram and P-h diagram of the system. Also calculate the COP of the system. **(20)**

2. (a) A packaged air conditioner serves three rooms in an apartment. The schematic layout of the duct system, together with the volume flow rate to each room, is shown in Fig. for Q. No. 2(a). (i) Size the duct system using the equal-friction method. The duct shall be of standard round sections with diameters in increments of 25 mm. The air velocity in the first section is not to exceed 8 m/s. (ii) Estimate the static pressure in the index run of the duct network. There is a pressure drop of 25 Pa at each of the outlet grilles at E, F and G. Assume the resistance due to the fittings as one-fifth that of the duct length. In the calculation, consider the resistance due to the elbow and Tee as 10 Pa and 15 Pa respectively. **(20)**

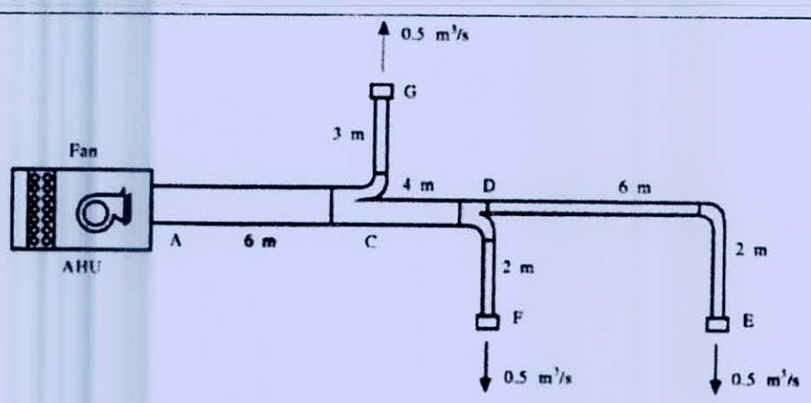

Figure for the Q. No. 2(a)

(b) Give brief description of major industrial and non-industrial fire accidents and sources of fire in Bangladesh. **(15)**

Contd P/2

ME 415

3. (a) Define fire, fire triangle and explain fire fundamentals in detail. Write short note on flammability and combustibility. **(20)**

   (b) Describe different type of fire protection systems in details with schematic diagram. **(15)**

4. (a) Describe different components of traction elevator system with schematic diagram. **(20)**

   (b) Write short notes about zoning of elevators and grouping of elevators. Compare elevator and escalator systems. **(15)**

SECTION – B

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

5. (a) Classify different types of compressor used in refrigeration systems along with their capacity ranges. Describe the working principle of a sliding and rotary vane compressor with proper schematic diagram. **(17)**

   (b) Describe the working principle of a thermostatic expansion device with necessary schematic diagram and identify its major components. Hence, explain how does it maintain a constant degree of suction superheat at the evaporator outlet. **(18)**

6. (a) Though the temperature at high altitude is lower than the earth surface, aircraft needs cooling, why is this cooling necessary? Hence, describe an air cycle refrigeration system with proper schematic diagram. **(17)**

   (b) Describe an aqua-ammonia vapor absorption refrigeration system with necessary schematic diagram. Hence, analyze the benefit of using two heat exchangers; one after the pump and the another before the expansion valve. **(18)**

7. (a) Why are two heat exchangers necessary before the first throttling in a Linde Liquefaction plant? Hence, describe this liquefaction plant for liquefying gas with neat sketch. Draw the necessary T-s diagram and explain. **(17)**

   (b) For the purpose of liquefaction of a gas by cooling cascade system is employed in refrigeration system. What are its special features due to which it can liquefy the gases? Hence, describe a ternary cascade refrigeration cycle for liquifying natural gas. **(18)**

Contd P/3

ME 415

8. Estimate the cooling load of a class-room for 65 students at 5 pm for the following conditions: **(35)**

Location	: Chattogram
Date	: June 15
Floor	: 10m × 7m, 3.0m height
Roof	: Type 5, without suspended ceiling, 25 mm wood, 25 mm insulation
Walls	: 254 mm brick with 12.5 mm plaster on both sides.
Windings	: 13% of wall area on north and west walls. 10 mm clear glass, $U = 2.7\ W/m^2.°C$
Light	: 22 W/m^2 fluorescent 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.

L-4/T-1/ME Date : 30/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2021-2022

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

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) Explain the 4 phases of a DI CI engine combustion. **(10)**

   (b) Explain the development of knock in SI engines. What are the key factors to affect SIE knock? **(10)**

   (c) Explain the physical meanings of **(15)**

   (i) laminar burning velocity

   (ii) flammability limits of fuel-air mixture

   (iii) self ignition temperature.

2. (a) Why are engine valves opened earlier and closed later? **(10)**

   (b) Make a brief comparison between engine turbocharging and engine supercharging. **(10)**

   (c) Define volumetric efficiency of engines. Explain how the following 2 parameters affect engine volumetric efficiency **(15)**

   (i) air-fuel ratio

   (ii) Latent heat of evaporation of fuel.

3. (a) Explain 'similitude principle' used in engine design. Show how it can be used to address inlet air temperature on η_v. **(10)**

   (b) Compare knock in SI and CI engines. **(10)**

   (c) Explain the zones identifiable in gas turbine combustion. Why is temperature of flue gases from GT high although burring is very lean? **(15)**

4. (a) Derive the engine power equation: **(25)**

$$\text{bmep} = \eta_i \eta_c \eta_m \eta_v \left\{ \rho_{a,i} \left(\frac{F}{A} \right) Q_{LHV} \right\}$$

   explain the physical meaning of 'bmep' and the bracketed term in the equation. Mention the typical values of bmep's in SI and CI engines.

   (b) Explain and roughly quantify the deviation of actual SI engine cycle from otto cycle. **(10)**

Contd P/2

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SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
Symbols indicate their usual meaning.

5. (a) Classify SI and CI engine in terms of fuel intake method. What is the typical direct injection CI engine fuel injection pressure? Justify your answer. **(9)**

   (b) Name the engineers who were instrumental in developing the two-stroke cycle internal combustion engine. "Most of the very large engines operate on a two-stroke cycle" – Do you agree with this assertion? Justify your answer. **(9)**

   (c) Briefly discuss the operation of a port fuel injection SI engine's fuel injection system. **(9)**

   (d) Draw the ideal *p-V* diagram of throttled constant-volume and supercharged constant-volume four-stroke IC engine cycles. **(8)**

6. (a) Sketch the *p-V* diagram of constant-volume, constant-pressure and limited-pressure four-stroke IC engine cycles for fixed compression ratio and unburned mixture composition. **(9)**

   (b) An overexpanded four-stroke SI engine's *imep* significantly decreases as the expansion ratio increases – Give brief reasoning for this statement. **(8)**

   (c) With neat sketches show the effect of compression ratio, residual mass fraction, and intake-exhaust pressure ratio on the *imep* of fuel-air otto cycle. **(12)**

   (d) For a fixed compression ratio, the constant pressure cycle always has a higher $imep/p_3$ than the constant volume cycle. Is the same true for $\eta_{f,ig}$? **(6)**

7. (a) Discuss the principal mechanisms responsible for the exhaust hydrocarbon emission in SI engines. **(11)**

   (b) Briefly discuss the trade-off between combustion process control of NO_x and particulate formation in diesel engines. **(8)**

   (c) Name the IC engine pollutants that are being detected by the following techniques. Also, explain the working principle of one of the following emission measurement methods. **(9)**

   (i) Flame Ionization Detector (FID)
   (ii) Nondispersive Infrared Analyzer (NDIR)
   (iii) Chemiluminescence Detector (CLD)

   (d) Write a short note on the after-treatment devices that are typically being used for emission control in lean combustion engines. **(7)**

8. (a) Calculate the actual air-fuel ratio for an engine running with octane (C_8H_{18}) at a rich condition. Use the equivalence ratio of 1.2 for your calculation. **(9)**

   (b) Define adiabatic flame temperature (T_{ad}). Why T_{ad} is highest at slightly rich condition? **(7)**

   (c) "A good SIE fuel is s bad CIE fuel, and vice versa" – Give brief reasoning for this statement. **(7)**

   (d) Sketch a pie chart showing the typical CI engine energy balance. **(7)**

   (e) What functions does lubricant serve in IC engines? **(5)**

L-4/T-1/ME Date : 19/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2021-2022

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

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

The figures in the margin indicate full marks.

Assume reasonable value for missing data. Symbols have their usual meaning.

1. (a) State and explain the impulse-momentum principle used for the operation of fluid machinery and 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 a series of curved vanes moving in the same direction of the jet. The vane deflects the jet through an angle of 160°. If the relative velocity is reduced by 10% due to friction and there is windage loss of $u^2/2g$ m of water, determine (i) the velocity of vane corresponding to the maximum efficiency, (ii) the resultant force on the vane and its direction. 'u' is the velocity of vanes. **(18)**

2. (a) Discuss the working proportions of Pelton wheel related to its different components. Also evaluate the number of buckets for efficient performance of wheel. **(18)**

   (b) A Pelton wheel is rotating at a speed of 680 rpm. The bucket deflects the jet through an angle of 165°. The diameter of the jet is 90 mm and the velocity of jet is 110 m/s. The ratio of speed is 0.47 and the coefficient of jet is 98%. Neglecting friction, find the (i) wheel diameter, (ii) generated power, and (iii) loss of energy by exit water. **(17)**

3. (a) Define unit quantities related to hydraulic turbine and using this concept derive an expression of specific speed. **(17)**

   (b) An inward flow reaction turbine has inner and outer diameters of 0.6 m and 1.0 m, respectively. The constant velocity of flow is 5 m/s and the speed of the turbine is 300 rpm. The width of the runner at inlet is 100 mm and guide blade angle is 15°. If the flow at the outlet is radial, find (i) blade angle at inlet and outlet, (ii) width of runner at outlet, (iii) power developed, and (iv) hydraulic efficiency. **(18)**

4. (a) Based on the operational characteristics, differentiate between Francis turbine and Kaplan turbine. **(8)**

   (b) What is torque converter? Describe the working principle of a torque converter and differentiate it with fluid coupling regarding their performances. **(15)**

   (c) A 1/10 scale model of a Kaplan turbine is working under a head of 6 m. The prototype develops 9 MW at 150 rpm under a head of 12 m. The overall efficiency of prototype is 85%. Find the speed and discharge of the model. Also find the specific speed of the turbine. **(12)**

Contd P/2

ME 421

SECTION – B

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

The questions are of equal value. Assume reasonable data if necessary.

5. (a) With the help of a neat sketch discuss the functions and working principle of air vessel in a reciprocating pump.

   (b) A single acting reciprocating pump has a bore of 500 mm and a stroke of 500 mm respectively. The pump delivers 0.11 m^3/s of water against a head of 100 m. The head loss due to friction in suction and delivery pipes are 2 m and 14 m respectively. The velocity of water in the pipe is 1.5 m/s. If the pump efficiency is 90% and the slip is 6%, calculate the speed of the pump and the power required to drive the pump.

6. (a) With neat sketches, describe main components of a centrifugal pump.

   (b) A centrifugal pump delivers 0.12 m^3/s of water against a head of 26 m. The outside diameter of impeller is 250 mm and it is 50 mm width at the outlet. If the monometric efficiency is 76%, find the vane angle at the outlet. The speed of the pump is 1500 rpm.

7. (a) Deduce Euler-momentum equation for pumps.

   (b) A centrifugal pump delivers 0.20 m^3/s water against a head of 26 m while running at 950 rpm. The constant velocity of flow is 2.9 m/s and the vanes are curved backward at an angle of 30° (outlet). If the hydraulic efficiency is 77%, find the diameter and the width of the impeller at outlet.

8. (a) Deduce an expression for work done against friction in pipes for a reciprocating pump. Discuss its effect on suction and delivery strokes.

   (b) The bore and stroke of a double acting reciprocating pump are 350 mm and 300 mm respectively. The pump delivers 0.038 m^3/s of water at 50 rpm through a total static head of 12 m. Find the slip and the actual power required to drive the pump with 75% efficiency.

L-4/T-1/ME Date : 08/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2021-2022

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

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**.

Symbols have their usual meaning.

1. (a) A thin square plate of unit dimension (1 × 1) is simply-supported along all its edges and carries a uniformly distributed load of intensity q. **(20)**

   Using the Navier's classical method of solution, determine,

   (i) the deflected form of the plate

   (ii) the distributions of bending moments

   (iii) maximum deflection and bending moments in the plate.

   (b) Describe the mathematical details of an efficient multi-step computational scheme to determine the numerical solution of deflection of a thin simply-supported rectangular plate. **(15)**

2. With a neat sketch, derive the DEQ that governs the deflection of a one-end fixed and the other end free slender column subjected to an eccentric axial loading. **(35)**

   Also show that,

   (a) the maximum compressive stress in the column depends on the eccentricity of loading.

   (b) the buckling load of the column is independent of the loading eccentricity.

3. (a) Define 'strain energy density'. **(18)**

   With necessary illustrations, derive the integral expressions of strain energy of an elastic bar subjected to

   (i) pure bending moment

   (ii) twisting moment

   (iii) shear force

   (b) A simply-supported beam of length L is loaded with a uniformly distributed load of intensity q over its full span and a point load P at its mid-span. If the flexural rigidity of the beam is given by EI, find the maximum deflection of the beam using complementary energy method. **(17)**

Contd P/2

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4. A propped cantilever beam of length L is subjected to a uniformly distributed loading with intensity q_0. Three concentrated forces (F_1, F_2, F_3) and moments (M_1, M_2, M_3) are also acting at the one-quarter (L/4), mid-span (L/2) and three-quarter (3L/4) sections of the beam, respectively. In addition, an axial compressive force (P) is acting at the simply-supported end. The entire beam is resting on an elastic foundation having the foundation modulus K. **(35)**

   (a) Give a neat sketch of the beam showing all the loading and supporting conditions.

   (b) Derive the DEQ that governs the deflection of the beam-column.

   (c) Give the physical and mathematical interpretation of the beam end conditions.

   (d) Find the integral expression of the net potential energy stored in the beam.

SECTION – B

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

5. (a) Define Hook's law. Using a 3-D stress element derive the stress-strain relations: the strain components as a function of stress components. **(12)**

   (b) From the relations derived in 5(a), express the stress components as a function of strain components. **(12)**

   (c) A solid aluminum shaft of 80 mm diameter carries an axial compressive load of 400 kN. If Poisson ration is 1/3 and Young's Modulus of aluminum is 70 GPa, determine the increase in diameter of the shaft under the load. **(11)**

6. (a) A specimen of any given material is subjected to a uniform triaxial stress. Determine the theoretical maximum value of Poisson's ratio. **(12)**

   (b) Derive the partial differential equations of equilibrium for a general 3-D elastic body. **(12)**

   (c) Consider a stress field as **(11)**

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

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

7. (a) With suitable examples, discuss the plane stress and plane strain problems. **(18)**

   (b) Investigate what problem is solved by **(17)**

$$\phi = -\frac{F}{d^3} xy^2 \left(3d - 2y\right)$$

   Applied to the region included in $y = 0$, $y = d$, $x = 0$, on the side x positive.

8. For a solid bar of elliptic cross section subjected to a uniform torque, T, determine the following: (a) A suitable stress function, (b) distribution of stresses, (c) maximum stress and its location, (d) Rate of twist, and (e) warping displacement in the bar. **(35)**

L-4/T-1/ME Date : 08/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2021-2022

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

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**.

Symbols used have their usual meaning and interpretation.

Assume reasonably any missing data. Short list of formulae is attached.

1. (a) At a distance of 1m from a *cylindrical* sound source, SPL is 100.6 dB at a frequency of 1 kHz. The receiver is at a distance of 11m from the source. Take, $\alpha = 0.16$ dB/m and acoustic impedance = 406 Rayls. **(20)**

   Calculate, at the position of the receiver (i) SPL (ii) sound intensity (iii) acoustic energy density (iv) particle displacement amplitude.

   (b) With necessary sketches define following terms: (i) a real sound field (ii) reverberation in an acoustic room (iii) sound diffusers. **(15)**

2. (a) A heavy-duty machine is to be installed in the machine room of an industry. Describe with necessary sketches and equations, the step-by-step procedure for such an installation as far as noise and vibration control is concerned. **(15)**

   (b) If an audio signal has 1/3rd octave band at a central frequency of 1.2 kHz and PBL of 105 dB, find PSL (f_c) and Sp (f_c). Take, $S_{ref} = 4 \times 10^{-10}$ Pa^2/Hz. **(10)**

   (c) Sketch followings: (i) The mechanism of diffraction of sound (ii) A standard acoustic board. **(10)**

3. (a) A factory room has a dimension of 15m × 10m × 8m. The absorption coefficients for floor, ceiling and walls are 0.1, 0.12 and 0.11 respectively. Calculate: (i) average absorption coefficient and RT at 1 kHz. (ii) A m/c is turned on and at a distance of 5m from the m/c a worker receives an SPL of 90 dB. If the directivity factor at the worker's position is 3, find the sources power in Watt. **(20)**

   (b) (i) List 5 bad effects of noise. **(15)**

   (ii) With neat sketches describe the working principle of an acoustic barrier.

4. (a) The base of a multi-storied building is subjected to a random acceleration input. It is desired to compute the response of any point p on the structure and establish the probability of exceeding any specified acceleration. Some experimental data are as follows: **(31)**

Contd P/2

ME 445

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

f (Hz)	Δf (Hz)	S (fi) (g^2/Hz)	G (fi) (g^2)	$\|H(fi)\|$ = a_p/a_0	S (fi) $\Delta f \|H(fi)\|^2$ (g^2)
0	100	0		1	
100		0		1	
200		0.3		1.1	
300		0.5		1.4	
400		1.25		2	

(i) Copy the table and complete the blank cells of the table.

Using the given probability tables and your calculation in (i), find the followings:

(ii) the maximum power spectrum.

(iii) the mean square output acceleration of the point *P*.

(iv) $p\left[a_{peak} > 2\hat{\sigma}\right] = ?$ and $p\left[|a| > 2\hat{\sigma}\right] = ?$

Gaussian probability

λ	Prob $[-\lambda\sigma \le x(t) \le \lambda\sigma]$	Prob $[\|x\| > \lambda\sigma]$
1	68.3%	31.7%
2	95.4%	4.6%
3	99.7%	0.3%

Rayleigh probability

λ	$P[A > \lambda\sigma]$
0	100%
1	60.7%
2	13.5%
3	1.2%

(b) A vibrating cantilever beam has a mass M at its free end. Specify its boundary conditions. **(4)**

SECTION – B

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

5. (a) List the differences between a velometer and an accelerometer. **(5)**

(b) Outline the bounds for the following vibration specifications in a plot: Max. acceleration = 3g, max. displacement = 2.5 mm, min. and max. frequencies: 1 Hz and 200 Hz. **(10)**

Contd P/3

ME 445

Contd ... Q. No. 5

(c) Specify the DOF and nature of vibration for the system shown in Fig. for Q. 5(c). Use the attached table of formulae to find the natural frequencies of the system. **(20)**

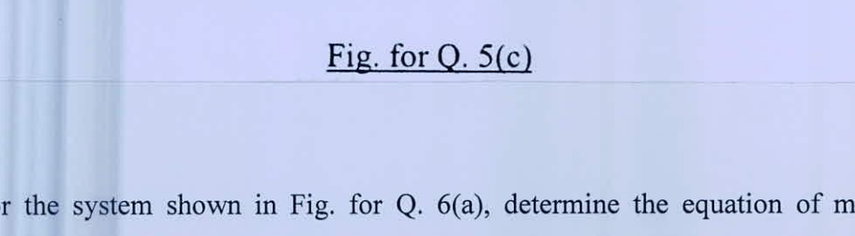

Fig. for Q. 5(c)

6. (a) For the system shown in Fig. for Q. 6(a), determine the equation of motions by Lagrange's method and hence find the natural frequency of oscillation of the system. Plot x-t curve assuming light damping. **(20)**

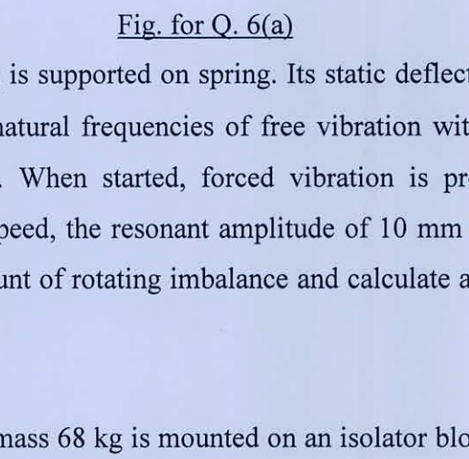

Fig. for Q. 6(a)

(b) A machine of 400 kg is supported on spring. Its static deflection is 10 mm, damping ratio, $\zeta = 0.18$. Find (i) natural frequencies of free vibration with and without damping and (ii) spring stiffness. When started, forced vibration is produced due to rotating imbalance. By varying speed, the resonant amplitude of 10 mm was recorded at critical speed. (iii) Find the amount of rotating imbalance and calculate amplitude of vibration at a speed ratio of $\beta = 10$. **(15)**

7. (a) An electric motor of mass 68 kg is mounted on an isolator block of mass 1200 kg and the natural frequency of the total assembly is 160 cpm with a damping factor of $\zeta = 0.10$. If there is an unbalance in the motor that results in a harmonic force of $F = 100 \sin(31.4t)$, determine (i) the amplitude of vibration of the block and (ii) the force transmitted to the floor. **(17)**

Contd P/4

ME 445

Contd ... Q. No. 7

(b) For the system shown in Fig. for Q. 7(b), W_1 = 90.7 kg and the absorber weight W_2 = 23 kg. If W_1 is excited by a 226 N-mm unbalance rotating at 1800 rpm, determine the proper value of the absorber spring stiffness k_2. What will be the amplitude of W_2? **(18)**

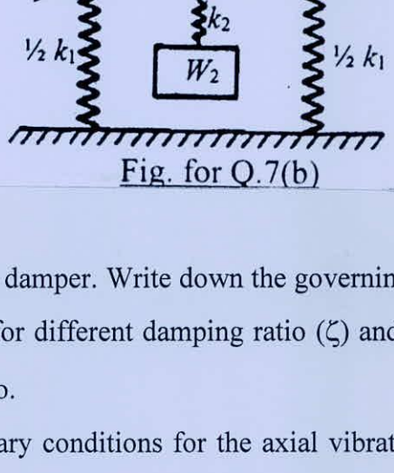

Fig. for Q.7(b)

8. (a) Sketch a Houdaille damper. Write down the governing equations. Plot its response vs. speed ratio (β) curve for different damping ratio (ζ) and mention the significance of the optimum damping ratio. **(10)**

(b) Specify the boundary conditions for the axial vibration of the system shown in Fig. for Q. 8(b). **(10)**

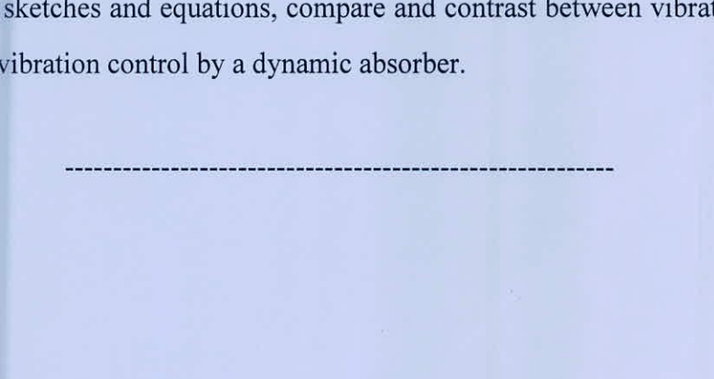

Fig. for Q. 8(b)

(c) With neat sketches and equations, compare and contrast between vibration control by isolation and vibration control by a dynamic absorber. **(15)**

Contd P/5

ME445 Short list of formulae

$H(\omega) = \frac{\bar{X}}{F_0} = \frac{1/k}{1-(\omega/\omega_n)^2 + i2\zeta\omega/\omega_n}$	$\frac{M}{m}\frac{X}{e} = \frac{\left(\frac{\omega}{\omega_n}\right)^2}{\sqrt{\left[1-\left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left[2\zeta\frac{\omega}{\omega_n}\right]^2}}$
$\tan\phi = \frac{2\zeta\left(\frac{\omega}{\omega_n}\right)}{1-\left(\frac{\omega}{\omega_n}\right)^2}$	$TR = \left\lvert\frac{F_T}{F_0}\right\rvert = \sqrt{\frac{1+(2\zeta\omega/\omega_n)^2}{\left[1-(\omega/\omega_n)^2\right]^2 + [2\zeta\omega/\omega_n]^2}}$
$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_i}\right) - \frac{\partial T}{\partial q_i} + \frac{\partial U}{\partial q_i} = Q_i$	$(m_1m_2)\omega^4 - \{(k_1+k_2)m_2 + (k_2+k_3)m_1\}\omega^2 + \{(k_1+k_2)(k_2+k_3) - k_2^2\} = 0$
$R = \frac{1}{2}\dot{\vec{x}}^T[c]\dot{\vec{x}}$	$\lambda^2 - \left(\frac{k_1+k_2}{m_1} + \frac{k_2+k_3}{m_2}\right)\lambda + \frac{k_1k_2+k_2k_3+k_3k_1}{m_1m_2} = 0$
$\frac{\partial R}{\partial \dot{x}_i}$	$\omega_n = n\sqrt{\frac{R}{r}}$
$\left\lvert\frac{K\theta_0}{M_0}\right\rvert = \sqrt{\frac{\mu^2(\omega/\omega_n)^2 + 4\zeta^2}{\mu^2(\omega/\omega_n)^2(1-\omega^2/\omega_n^2)^2 + 4\zeta^2\left[\mu(\omega/\omega_n)^2 - (1-\omega^2/\omega_n^2)\right]^2}}$	$T = -m(R+r)n^2R\phi$
$f_u = 2^n f_l$ and central frequency, $f_c = \sqrt{f_l f_u}$	$J_{eff} = -\frac{m(R+r)^2}{1 - r\omega^2/Rn^2}$
Acoustic impedance = ρc = 406 rayls	Pressure amplitude, P = ω X ρ c = 2π f X ρ c
$\bar{\varepsilon} = l/c$	*Pressure band level = 20 log $_{10}$ p_{band}/p_{ref}*
RT = 0.161 V/A A = $\bar{\alpha}$ S = $\sum \alpha i Si$	Pressure spectral level, PSL (f) = 10 $\log_{10}$ [S_p (f) /S_{ref}]
$L_p = L_W + 10\log_{10}(Q_\theta/4\pi r^2 + 4/\bar{\alpha}S)$	$N_F = (D_1 + D_2 - S)/(\lambda/2)$ IL = 16 + 10 log N_F

L-4/T-1/ME **Date : 08/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2021-2022

Sub : **ME 463** (Petroleum 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**.

Symbols have their usual meaning. Assume any reasonable data if missing.

1. (a) For spherical grains in cubic packing show that the porosity is independent of grain size and its value is 48%. **(10)**

   (b) Define critical Oil, Gas and Water saturations in context to petroleum reservoir. Outline the variation of oil and water saturations for "Water-wet rock" and "Oil-wet rock" in suitable sketch. **(15)**

   (c) Write short note on: **(10)**

   (i) Capillary Hysteresis (ii) Thermal EOR

2. (a) With the help of PT phase diagram, explain the characteristics of: **(15)**

   (i) Dry Gas Reservoir (ii) Gas Condensate Reservoir (iii) Black Oil Reservoir

   (b) What do you understand by "Primary Reservoir Drive Mechanism"? Mention key primary reservoir drive mechanisms. Describe any three of in terms of pressure, water cut and GOR (Gas Oil Ratio) variations with time. **(20)**

3. (a) Differentiate Resource and Reserve. Explain Resource-Reserve conversion with the help of "McKelvey's Box". Briefly explain WPC's 1P, 2P and 3P reserves. **(15)**

   (b) Consider the following data of a Gas Reservoir Estimation: **(20)**

   Area = 200 acres

   Pay Zone Thickness = 35 ft

   Initial Reservoir Pressure = 3250 psia

   Porosity = 25%

   Connate water = 23%

   Initial gas FVF = 0.00533 ft^3/SCF

   Gas FVF at 2500 psia = 0.00667 ft^3/SCF

   Gas FVF at 500 psia = 0.03623 ft^3/SCF

   S_{gr} after water invasion = 34%

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Based on these data, estimate:

(i) Initial gas in place

(ii) Gas in place after volumetric depletion to 2500 psia

(iii) Gas in place after volumetric depletion to 500 psia

(iv) Gas in place after water invasion at 3250 psia

(v) Gas in place after water invasion at 2500 psia

(vi) Gas in place after water invasion at 500 psia

(vii) Gas reserve by volumetric depletion to 500 psia

(viii) Gas reserve by full water drive at 3250 psia

(ix) Gas reserve by partial water drive at 2500 psia

4. (a) For an oil well that follows Harmonic Decline (b = 1), prove that the ln(q) vs. Cumulative production (Q) curve has a linear profile with a slope of "–1/k", where: q: Production rate; Q: Cumulative Production; b, k: Empirical constants. **(15)**

(b) Why is well casing so important? With nest sketch, show different types of casing done in conventional drilling. **(10)**

(c) "Down is the new Up" – why? Outline various Mechanical Design Challenges in your consideration for future petroleum industry. **(10)**

SECTION – B

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

5. (a) Write down the characteristics of drill holes used in petroleum engineering. **(17 ½)**

(b) With the help of a neat sketch describe the cable tool drilling. **(17 ½)**

6. (a) Explain the term "petroleum" with reference to petroleum engineering. Classify petroleum and petroleum like substance. **(17 ½)**

(b) Describe in short the details of the structure of the earth with neat sketches. **(17 ½)**

7. (a) Mention the features of a good petroleum reservoir. **(17 ½)**

(b) Describe the important mechanical properties of rocks. **(17 ½)**

8. (a) Explain the mechanisms of primary and secondary petroleum migration. **(17 ½)**

(b) Discuss the pre-conditions of petroleum accumulation in brief. **(17 ½)**

L-4/T-1/ME Date : 08/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2021-2022

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 and symbols have their usual meaning.

1. (a) What choices can you make for an automobile to reduce the cooling load. Briefly explain how a TXV functions to meet the variation of cooling load in an automobile AC system. **(12)**

   (b) How can you distinguish between condenser and radiator used in an automobile? Briefly explain. **(6)**

   (c) Briefly explain the terms "Rear Spoiler" and "Rear Defogger". **(6)**

   (d) What is an SRS Airbag? Briefly explain how it can protect a driver. **(11)**

2. (a) Distinguish between "Push Start" and "Jump Start" of an automobile. What are the things you need to check before trying to "Push Start" a car? **(10)**

   (b) Briefly explain why a "Single Wire" configuration is used for a car electric system. **(8)**

   (c) What is an "Emulator"? Why do we need to use it for CNG conversion of some cars? **(8)**

   (d) What do you understand by a "Type-2" CNG cylinder? Compare the energy density of a CNG-filled cylinder compared to a petrol tank of equal volume. **(9)**

3. (a) How can you identify a tubeless tyre? Briefly explain the advantages of driving a tubeless tyre. **(11)**

   (b) An automotive tyre is designed as – 200/70 R 15 V TWI. What do you understand from the tyre specification? **(6)**

   (c) Define "Pitch" and "Heave" motions of a car? Give example of such car motions. **(6)**

   (d) Deduce expressions for "Overturning" and "Skidding" speeds for a car taking a turn on a flat curved road. How does the vehicle mass influence the safe speed limit of turning? **(12)**

4. (a) Distinguish between BEV and PHEV automobiles. Compare the battery ranges of these two types. **(9)**

   (b) How can you ascertain the state of charge of a Pb-Acid automotive battery? Briefly explain. Does ambient temperature play any role in this process? **(10)**

   (c) Why do we use an alternator for charging a DC battery? How does an alternator meet the charging requirement of a battery? **(9)**

   (d) What do you understand by VIN? Briefly explain. **(7)**

Contd P/2

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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) Describe the functions of a clutch in a manual transmission system vehicle. **(7)**

   (b) Compare manual transmission versus auto transmission systems on the basis of drive control, vehicle cost, fuel economy, maintenance, efficiency, traffic condition, driver's feeling and cooling requirement. **(9)**

   (c) What are the major components of an automatic transmission system vehicle? List the typical gear positions in an automatic transmission system. **(9)**

   (d) Using schematic diagrams, explain how a torque converter accomplishes torque multiplication. What is the typical torque multiplication ratio of a torque converter? **(10)**

6. (a) Explain how the 'steering-gear-ratio' and 'steering-power-assist' system affect the steering system. **(6)**

   (b) Compare hydraulic power steering versus electrical power steering systems. **(8)**

   (c) What are the advantages of a four-wheel steering system? Illustrate how the four wheels turn in a four-wheel steering system when steering at low speed and at high speed. **(6)**

   (d) List the parameters which constituted the 'front-end geometry' of a vehicle. With schematics, describe the physical importance of any two of them. **(15)**

7. (a) Describe the different factors which influence the typical stopping distance of a vehicle during braking. **(8)**

   (b) Compare disc brakes versus drum brakes on the basis of construction, braking effectiveness, cost and maintenance. **(10)**

   (c) What are ABS and TCS? Briefly state how they function. **(7)**

   (d) Write a short note on 'regenerative' braking. **(10)**

8. (a) Describe the functions of an open type differential. Why is a 'limited slip' differential used? **(9)**

   (b) Make a list of different arrangements of front and rear suspension systems. **(8)**

   (c) Compare 'semi-active' versus 'active' suspension systems. **(6)**

   (d) What are the advantages of Macpherson-strut type front suspension system? With appropriate sketches, describe its construction and functions. **(12)**

L-4/T-1/ME Date : 03/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2021-2022

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) What socio-economic roles are played by machine tools for the industries? Explain the functions of major components common to all conventional machine tools. **(10)**

   (b) State the locations and functions of the head-stock, tailstock, carriage and work-tool holding devices in center lathes with the help of simple line diagram. **(10)**

   (c) Describe briefly with the help of a block diagram, the major aspects that are associated with machine tools engineering. Also show the interconnections amongst those aspects. **(15)**

2. (a) "Machine tools basically produce some geometrical surface on solid bodies" – justify the statement. **(10)**

   (b) Briefly explain with the help of suitable diagrams the principle of production of flat surfaces and cylindrical surfaces with the help of Generatrix and Directrix. **(10)**

   (c) With the help of suitable illustrative diagrams, connect the G and D with CM/FM, T/W and the ways of getting G and D in cases of (i) Boring, (ii) Drilling, (iii) Slotting and (iv) Grooving. **(15)**

3. (a) State the basic functions of the kinematic structure of machine tools. Also explain the functional principle of each kinematic chain in the kinematic structure of any machine tool. **(10)**

   (b) Explain by block diagram the roles of several mechanisms, kinematic chains and the overall kinematic structure in deriving power and motions from the power source(s) for the tool-work. **(10)**

   (c) Briefly describe with the help of a simple diagram the construction and functioning of a K_{35} type compound kinematic structure of any machine tool. **(15)**

4. (a) Illustrate with examples the difference between (i) stepped drive and stepless drive and (ii) positive drive and non positive drive in respect of machine tools. **(15)**

   (b) Name and schematically show the different mechanisms that are used in machine tool kinematic systems for transforming rotary motion to translation motion. **(10)**

   (c) State the advantages and limitations of hydraulic drive over mechanical drive in machine tools. What factors need to be considered while selecting motor for any machine tool drive? **(10)**

Contd P/2

IPE 431/ME

SECTION – B

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

Make appropriate assumptions for any missing data.

5. (a) Write down the kinematic advantages of the Geometric Progression (GP) series. **(5)**

   (b) For Z = 2(3) 3(6) 3(1), draw the structural diagram. For this structural diagram, determine the maximum transmission range in the speed box. **(15)**

   (c) If n_1 = 30 rpm, n_z = 375 rpm, and Z = 12, find the spindle speeds according to Arithmetic Progression (AP) series and Geometric Progression (GP) series (n_1, n_z and Z have their usual meanings). Which one is the best among these two series, and why? **(15)**

6. (a) Classify the machine tools according to the types of motions used for removing material. **(5)**

   (b) What is slideway? Why is it necessary? Briefly discuss different requirements of slideways that must be satisfied for machine tools. **(15)**

   (c) With appropriate diagrams, contrast Truing and Dressing. Why should a dull, glazed, or loaded wheel be dressed before grinding? **(15)**

7. (a) What are the basic differences between a jig and a fixture? **(5)**

   (b) Explain the necessity of differential indexing. **(15)**

   (c) Briefly dscribe different types of motions involved in the Gear Shaper with a suitable diagram. **(15)**

8. (a) What are the main advantages of using Turret Lathe? **(5)**

   (b) Explain the principal movement of the Engine Lathe with the help of an appropriate flow diagram. **(15)**

   (c) Write down the main dimensions of the Engine Lathe.

   In the two-feed method for performing the taper turning operation in the Engine Lathe, if the longitudinal feed is 0.5 mm/rev, the cross feed is 0.4 mm/rev, and the required taper angle is 15°. Then, determine the setting angle of the swivel plate. **(7+8=15)**
