2018-19
AUTUMN SEMESTER FINAL YEAR
B.E. EXAMINATION (MECHANICAL ENGINEERING)
MECHANICAL VIBRATIONS
EME 411

Maximum Marks: 60
Duration: Two Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question M.M.

1(a) Determine the Fourier series expansion for the periodic function shown in Figure-1. [7]

![Figure-1](image)

1(b) What are the common types of damping? Explain the hysteresis loop for elastic material. [5]

OR

1'(a) State and explain logarithmic decrement. Show that the logarithmic decrement is given by \( \delta = \frac{1}{n} \ln \frac{x_n}{x_0} \), where \( x_n \) represents the amplitude after \( n \) cycles have elapsed. [6]

1'(b) A single degree of freedom viscously damped system has a spring stiffness of 6000 N/m, critical damping constant 0.3 Ns/mm and a damping ratio of 0.3. If the system is given an initial velocity of 1 m/s, determine the maximum displacement of the system. [6]

2(a) Find the steady-state response of the system shown in Figure-2, for the following data: [6]

\( m = 10 \text{ kg}, \ r = 5 \text{ cm}, \ k_1 = 500 \text{ N/m}, \ k_2 = 1000 \text{ N/m}, \ c = 500 \text{ N-s/m}, \ J_0 = 1 \text{ kg-m}^2, \omega = 20 \text{ rad/s}, \ F_0 = 50 \text{ N}. \)
2(b) Consider a spring-mass system, with \( k = 4000 \text{ N/m}, \ c = 40 \text{ N-s/m}, \) and \( m = 10 \text{ kg} \) subjected to a harmonic force \( F(t) = 200 \cos 20t \text{ N}. \) Find the total response of the system under the following initial conditions:
\[ x_0 = 0.1 \text{ m}, \ \dot{x}_0 = 0. \]

3(a) Explain the following:
(i) Principal coordinates and their use
(ii) Vibration absorbers and their function.

3(b) Set up the differential equations of motion for the double pendulum shown in Figure-3, using the coordinates \( x_1 \) and \( x_2 \) and assuming small amplitudes. Find the natural frequencies, the ratios of amplitudes, and the locations of nodes for the two modes of vibration when \( l_1 = l_2 = l \) and \( m_1 = m_2 = m. \)
4 Define the flexibility and stiffness influence coefficients. What is the relation between them? Derive the flexibility matrix of the spring-mass system shown in Figure-4, assuming that all the contacting surfaces are frictionless.

![Diagram of a spring-mass system](image)

Figure-4

**OR**

4' The mass and stiffness matrices of a spring-mass system are known to be

\[
[m] = m \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 2 \end{bmatrix} \quad \text{and} \quad [k] = k \begin{bmatrix} 2 & -1 & 0 \\ -1 & 3 & -2 \\ 0 & -2 & 2 \end{bmatrix}
\]

Using the matrix iteration method, find the first two natural frequencies and mode shapes of the system.

5 Derive the free vibration equation for a longitudinal rod of length \( l \), area \( A \), density \( \rho \), and Young's modulus \( E \). Also obtain the natural frequency and mode shape for a bar having end condition fixed-free.
**2018-19**  
**B.E. (AUTUMN SEMESTER) EXAMINATION**  
**MECHANICAL ENGINEERING**  
**AUTOMOTIVE ENGINEERING**  
**EME-426**

Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

*Answer all the questions.*  
*Assume suitable data if missing.*  
*Notations used have their usual meaning.*

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
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</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>What do you mean by firing order of an engine and on what factors it depends.</td>
<td>[04]</td>
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<tr>
<td>1(b)</td>
<td>Why is cooling necessary for I.C. Engines? What is the function of thermostat in a cooling system? What is the role of viscosity of a lubricating oil?</td>
<td>[08]</td>
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**OR**

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<tr>
<td>1(b)</td>
<td>What are the advantages and disadvantages of hydraulic brakes? Explain the working of disc brake system with neat sketch.</td>
<td>[8]</td>
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<tr>
<td>2</td>
<td>List the different factors affecting carburetion. Explain working of power enrichment system with neat sketch. Differentiate between D-MPFI system and L-MPFI system.</td>
<td>[12]</td>
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**OR**

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<tr>
<td>2'</td>
<td>List the elements of a fuel injection system. What is the function of a nozzle? Discuss different types of nozzles used in fuel injection system.</td>
<td>[12]</td>
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<tr>
<td>3</td>
<td>Describe with the help of suitable sketch:</td>
<td>[12]</td>
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<tr>
<td></td>
<td>(i) Electronic ignition system.</td>
<td></td>
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<td></td>
<td>(ii) Battery ignition system</td>
<td></td>
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<tr>
<td>4</td>
<td>Describe the following:</td>
<td>[4+4+4]</td>
</tr>
<tr>
<td></td>
<td>i. Propeller shaft</td>
<td></td>
</tr>
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<td></td>
<td>ii. Differential</td>
<td></td>
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<tr>
<td></td>
<td>iii. Constant mesh gear box</td>
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<tr>
<td>5</td>
<td>Briefly explain any three of the following:</td>
<td>[4+4+4]</td>
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<tr>
<td></td>
<td>(i) Wheel alignment</td>
<td></td>
</tr>
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<td></td>
<td>(ii) Wheel angles</td>
<td></td>
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<td></td>
<td>(iii) Catalytic converter</td>
<td></td>
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<tr>
<td></td>
<td>(iv) Rack and pinion steering gear</td>
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2018-19
B.E. (AUTUMN SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
POWER PLANT ENGINEERING
EME428

Maximum Marks: 60
Credits: 04
Duration: Two Hours

Answer all the questions.
Use of Steam Table and Calculator is allowed. Assume suitable data if missing.
Notations used have their usual meaning.

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<td>1(a)</td>
<td>Discuss direct energy conversion systems. Explain the working of a thermoelectric conversion system.</td>
<td>[08]</td>
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<tr>
<td>1(b)</td>
<td>Explain the working of fuel cell and write the name of any two types of fuel cells.</td>
<td>[07]</td>
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<td>OR</td>
<td>1(b’) What are the advantages of hydroelectric power plant? Discuss the site selection criteria for steam power plant.</td>
<td>[07]</td>
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<tr>
<td>2(a)</td>
<td>What are the merits and demerits of a natural draught system in a boiler? A boiler is equipped with 25 m high chimney. The average temperature of flue gases in the chimney is 320 °C and the ambient temperature is 25 °C. The discharge of flue gases from the chimney is measured to be 21 kg of per kg of fuel burnt. Calculate the theoretical draught in terms of mm of water column and metre of hot gas column. Also make calculations for the velocity of flue gases in the chimney if 60% of the draught is lost in friction at grate and passages.</td>
<td>[08]</td>
</tr>
<tr>
<td>2(b)</td>
<td>Explain the working of a Stirling boiler with the help of neat sketch.</td>
<td>[07]</td>
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<td>OR</td>
<td>2’(a) Explain the fluidized bed combustion system with neat sketches. Also, discuss its advantages.</td>
<td>[07]</td>
</tr>
<tr>
<td>2’(b)</td>
<td>Define equivalent evaporation and boiler efficiency. A boiler evaporates 5 kg of water per kg of coal burnt in the combustion chamber.</td>
<td>[08]</td>
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</table>
The temperature of feed water is 30°C and the steam is raised at 10 bar absolute pressure. Calculate the equivalent evaporation from and at 100°C per kg of coal and the boiler efficiency if the steam produced is (a) 0.95 dry (b) superheated at 250°C. Take calorific value of coal used is 32.5 MJ/kg.

3(a) Explain Pressurized water reactor (PWR) with the help of schematic diagram. Also discuss the function of a pressurizer in PWR.

3(b) Explain the gas turbine-steam turbine combined power plant with the help of schematic diagram and T-s plot.

4(a) Define load factor, use factor, capacity factor and diversity factor. How the load factor can be improved?

4(b) Explain compressed air method of energy storage in power plant.

4(c) A thermal power plant consist of two 60 MW units, each running for 8000 hours, and one 30 MW unit running for 2000 hours per year. The energy produced by the plant is 876 x 10⁶ kWh per year. Determine the plant load factor and plant use factor. Consider the maximum load equal to the plant capacity.

OR

4(c') A power plant of 210 MW installed capacity has the following particulars:
- Capital cost = Rs. 18,000/kW installed
- Annual load factor = 60%
- Annual capacity factor = 54%
- Annual running charges = Rs. 200 x 10⁶
- Energy consumed by power plant auxiliaries = 6%

Calculate (a) the cost of power generation per kWh and (b) reserve capacity.
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.
Draw the vector diagram wherever necessary.

Q. No.  Question  M.M.
1(a) Explain the following terms; [06]
   i) Impulse and reaction turbines,
   ii) Unit and specific speed of the turbine, and
   iii) Volumetric and mechanical efficiency of a turbine.

1(b) A single jet Pelton turbine having 100MW output works under a head of 500m. If [06] the specific speed of the turbine is 30 (metric unit), its overall efficiency is 0.8 and coefficient of velocity is 0.98, find the diameter of the jet and the rotor. Take speed of buckets as 0.46 times the speed of jet.

OR

1(b)' A Kaplan turbine working under a head of 20m develops 11772kW shaft power. The [06] outer diameter of the runner is 3.5m and hub diameter is 1.75m. The guide blade angle at the edge of runner is 35°. The hydraulic and overall efficiency are 88% and 84%. If the velocity of whirl at outlet is zero, determine,
   i) Runner blade angle at inlet and outlet at the extreme edge of runner.
   ii) Speed of the turbine.

2(a) Explain briefly the function of draft tube and prove that the draft tube establishes a [06] negative head at the runner outlet of the turbine.

OR

2(a)' For Pelton turbine prove that, [06]
   \[ U = \frac{V_1}{2}, \text{ and } \eta_m = \frac{(1+k\cos \beta_2)}{2} \]

2(b) A Francis turbine with a hydraulic efficiency of 78% and overall efficiency of 75% [06] is required to produce 148.25kW power. It is working under a head of 7.62m. The peripheral velocity is 0.26(2gH)^{1/2} and the radial velocity of flow at inlet is 0.96(2gH)^{1/2}. The wheel runs at 150rpm and the hydraulic losses in the turbine are 22% of the available energy. Assume radial discharge, determine,
   i) The guide blade angle,
   ii) The wheel vane angle at inlet,
   iii) Diameter of the wheel at the inlet, and
   iv) Width of the wheel at the inlet.

3(a) Explain the phenomenon of cavitation in centrifugal pumps. Why backward curve [06] blades are used in centrifugal pumps.
3(b) A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000rpm, works against a total head of 40m. The velocity of flow through the impeller is constant and equal to 2.5m/s. The vanes are set back at an angle of 40° at outlet. If the outer diameter of the impeller is 500mm and width at the outlet is 50mm. Determine,
   i) Vane angle at inlet,
   ii) Work done by impeller on water per second, and
   iii) Manometric efficiency.

OR

3(b') For centrifugal pump explain briefly,
   i) Operating characteristic curves,
   ii) Constant efficiency curves, and
   iii) Constant head and discharge curves.

4(a) Explain briefly the following terms,
   i) Pre-whirl,
   ii) Degree of reaction, and
   iii) Stalling.

4(b) A centrifugal compressor has a pressure ratio of 4:1 with an isentropic efficiency of 82% when running at 16000rpm. It takes in air at 17°C. Guide vanes at inlet give the air a pre-whirl of 20° to the axial direction at all radii and the mean diameter of the eye is 200mm, the absolute air velocity at inlet is 120m/s. At exit, the blades are radially inclined and the impeller tip diameter is 550mm. Calculate the slip factor of the compressor.

OR

4(b') A multi-stage axial flow compressor consumes 4.41MW while delivering 20kg/s of air from stagnation condition of 1bar absolute and 288°K. If the polytropic efficiency of each stage is 0.9 with constant stagnation pressure ratio, find:
   a) Pressure at compressor outlet
   b) Fix the number of stages and
   c) Find overall isentropic efficiency of compressor.

Temperature rise in the first stage may be taken as 20°C. Neglecting mechanical losses.

5(a) Explain with the help of a suitable diagram the working of a hydraulic coupling.

OR

5(a') Prove that the friction and acceleration head is reduced due to fitting of air vessel in a reciprocating pump.

5(b) A hydraulic lift raises a load of 8.75 tonnes at a speed of 0.5m/s through a height of 13.5m once in 96 seconds, being worked from an accumulator which is fed by a pump of efficiency 80%. If the pressure of water is 70bar and efficiency of lift is 90%. Neglecting other losses, find,
   i) Power input to the pump, and
   ii) Minimum capacity of accumulator.