Maximum Marks: 60  
Duration: 02 Hours  
Credits: 04

Attempt all questions

1(a) Differentiate between:
   (i) Compaction and Hot Pressing.  
   (ii) Sintering and Pre Sintering.  
   (iii) Impregnation and Infiltration.

1(b) How are self-lubricated bearings fabricated?

2 Explain the following methods used for manufacturing of metal powders.
   (i) Crushing
   (ii) Shotting
   (iii) Electrolysis
   (iv) Atomization
   (v) Vapour Condensation

OR

2' Explain in detail the effect of the following characteristics of metal powders on the final product.
   (i) Chemical composition and purity.
   (ii) Size of particle and distribution.
   (iii) Flowability.
   (iv) Sintering ability.

3 Write notes on the following
   (i) Powder Rolling.
   (ii) Powder Forging.
   (iii) Steam Treatment.

4(a) Describe in detail advantages of powder metallurgy process including.
   (i) Process Advantages
   (ii) Metallurgical Advantages
   (iii) Commercial Advantages

OR

4(a') Write a detailed note on applications of Powder metallurgy in various fields.

4(b) Explain the following terms:
   (i) Isostatic Pressing
   (ii) Liquid Phase Sintering.
2018-19
AUTUMN SEMESTER IV YEAR
B. TECH. EXAMINATION (MECHANICAL ENGINEERING)
MECHANICAL VIBRATIONS (ME 411)

Maximum Marks: 60

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

Q.No.  Question  M.M.

I(a)  The impact force created by a forging hammer can be modelled as Figure-1. Determine the Fourier series expansion of the impact force. \{CO1\}

\[ t \]
\[ \frac{\pi}{2} \]
\[ \frac{3\pi}{2} \]
\[ 2\pi \]
\[ \frac{5\pi}{2} \]

Figure-1

I(b)  A scissors jack is used to lift a load \( W \). The links of the jack are rigid and the collars can slide freely on the shaft against the springs of stiffnesses \( k_1 \) and \( k_2 \) as shown in Figure-2. Find the natural frequency of vibration of the system in the vertical direction. \{CO2\}

Figure-2

contd...2.
2(a) 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 \( F(t) = 500 \cos 30t \text{ N} \). Find and plot the total response of the system under the following initial conditions: \( x_0 = 0.1 \text{ m}, \dot{x}_0 = 10\text{ m/s} \) [8]

2(b) Design a vibrometer to measure amplitudes at a lowest frequency of 10Hz with an accuracy of at least 1.5%. Seismic mass is 1.0 kg. What is the stiffness of the spring and how much should be the damping in the system? [4]

3(a) Explain the following: [CO1]
   (i) Mass coupling, velocity coupling and elastic coupling.
   (ii) Principal coordinates and their use [4]

3(b) Figure-3 shows an overhead crane schematically. The cabin is at the center of beam of span \( l_1 \). Reduce the system to an equivalent two degrees of freedom system and determine the natural frequencies and corresponding mode shapes. Assume the following data: [8]

\[ EI = 21 \text{ MNm}^2; \quad m_1 = 3000 \text{ kg}; \quad l_1 = 5 \text{ m}; \quad EA = 82.47 \text{ MN}; \quad m_2 = 700 \text{ kg}; \quad l_2 = 6 \text{ m}. \]
3' Find the steady-state response of the system shown in Figure-4 when the mass is excited by the force $F_1(t) = F_{10}\cos(\omega t)$. Also, plot its frequency-response curve. {CO3}

![Figure-4](image)

4 For a three DOF undamped spring mass system shown in Figure-5, find the natural frequencies and corresponding mode shapes considering all masses are equal to $m$ and all stiffnesses are equal to $k$. {CO3}

![Figure-5](image)

4' Using Matrix Iteration method find out the first two natural frequencies and corresponding mode shapes for the following mass and stiffness matrices. {CO4}

$$m = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 2 \end{bmatrix}$$ and $$k = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 3 & -2 \\ 0 & -2 & 2 \end{bmatrix}$$

...contd....
A cable of length $l$ and mass per unit length is $\rho$ is stretched under a tension $P$. One end of the cable is connected to a mass $m$ which can move in a frictionless slot, and the other end is fastened to a spring of stiffness $k$ as shown in Figure 6. Derive the frequency equation for the transverse vibration of the cable. 

Figure 6
Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

**Q.No.** | **Question** | COs | M.M. |  
--- | --- | --- | --- |  
1(a) | Classify the hydrocarbon fuels and explain their applications accordingly. | CO1 | [06] |  
1(b) | Define the different thermal properties of hydrocarbon fuels. Find out the calorific value of the given fuel composition: \( \text{CH}_4 = 4\%, \text{C}_2\text{H}_6 = 3\%, \text{C}_3\text{H}_8 = 0.5\% \), and the rest are \( \text{N}_2 \) and \( \text{CO}_2 \). | CO1 | [06] |  
1(e) | How the gaseous fuels are superior to all other fuels. | CO1 | [03] |  
2(a) | Methane gas enters a steady flow adiabatic combustion chamber at 25°C and 1 atm. It is burned with 50% excess air at same conditions. Assuming complete combustion and the Adiabatic Flame Temperature is 1789 K, determine (a) entropy generation rate for this process (b) reversible work and exergy destruction. | CO2 | [09] |  
2(b) | Define chemical exergy. Find out the chemical exergy of methane. | CO2 | [06] |  

**OR**

2'(a) | Liquid propane (\( \text{C}_3\text{H}_8 \)) enters a combustion chamber at 25°C at a rate of 1.2 kg/min where it is mixed and burned with 150 percent excess air that enters the combustion chamber at 12°C. If the combustion is complete and the exit temperature of the combustion gases is 1200 K, determine (a) the mass flow rate of air and (b) the rate of heat transfer from the combustion chamber. | CO2 | [09] |  
2'(b) | Write down expressions for determining constant pressure and constant volume Adiabatic Flame Temperature (AFT) with respect to a liquid fuel burning stoichiometrically at 0.1 MPa and 298K with no dissociation. What is equilibrium adiabatic flame temperature? | CO2 | [06] |  
3(a) | Consider the following chain reaction mechanism for the high-temperature formation of nitric oxide, i.e. the Zeldovich mechanism: | CO3 | [07] |  

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continues...
Reaction 1: \[ N_2 + O \xrightarrow{K_1} NO + N \]

Reaction 2: \[ N + O_2 \xrightarrow{K_2} NO + O \]

For high temperature systems, in the above reactions (1 and 2) the NO formation is typically much slower than other reactions involving \( O_2 \) and \( O \), such that \( O_2 \) and \( O \) can be assumed to be in equilibrium which may be given as

\[ O_2 \xleftarrow{K_2} 2O \]

Construct a global mechanism

\[ N_2 + O_2 \xrightarrow{K_2} 2NO \]

which is represented as

\[ \frac{d[NO]}{dt} = K_d [N_2]^m [O_2]^n \]

Determine \( K_d, m, n \) using the elementary rate coefficients, from the above detailed mechanism.

3(b) Consider the detailed mechanism involved in the reaction of \( H_2 \) with \( Br_2 \) during the formation of Hydrogen Bromide (\( H_2 + Br_2 \rightarrow 2HBr \)) as follows:

- \( Br_2 \rightarrow 2 Br \)  \( \text{rate constant: } k_1 \)  (Initiation)
- \( Br + H_2 \rightarrow HBr + H \)  \( \text{rate constant: } k_2 \)  (Propagation)
- \( H + Br_2 \rightarrow HBr + Br \)  \( \text{rate constant: } k_3 \)  (Propagation)
- \( H + HBr \rightarrow H_2 + Br \)  \( \text{rate constant: } k_4 \)  (Termination)
- \( Br + Br \rightarrow Br_2 \)  \( \text{rate constant: } k_5 \)  (Termination)

Assuming the steady state approximation for \( H \) and \( Br \) atoms, write down the expression for \( (d[H]/dt)_{st} \) and \( (d[Br]/dt)_{st} \).

4(a) Define flame thickness. What is the significance of Mallard-Lechatelier’s thermal theory of laminar flame speed (No derivation is required).

4(b) Explain the spherically symmetric droplet combustion model, discussing in detail the assumptions made. What is the \( d^2 \)-law of combustion and what are its limitations.

OR

4’(a) Show the effect of ambient temperature, pressure and equivalence ratio on the laminar flame speed with the help of suitable diagrams.

4’(b) Draw and explain the Hugoniot curve and verify using the relation:

\[ \gamma M_1^2 = (P_2 / P_1 - 1) / (1 - (1 / \rho_2 / \rho_1)) \]

that regions I and IV correspond respectively to strong detonation and strong deflagration and region V is imaginary.
2018-19
B.TECH. (AUTUMN SEMESTER) EXAMINATION
(MECHANICAL ENGINEERING)
AUTOMOTIVE ENGINEERING
(ME-426)

Maximum Marks: 60 Credits: 04 Duration: Two Hours

Answer all the questions.

Q.No. Question CO M.M.

1(a) What are the factors responsible for selecting the firing order in an IC engine? CO2 [06]
Determine the firing order of eight cylinder, four stroke inline engine.

1(b) Why cooling of internal combustion engine is necessary? Explain briefly various CO3 [06]
cooling systems used in IC engines with the help of suitable sketch.

OR

1'(a) What do you mean by Anti-lock Braking System (ABS)? Explain with the help of CO4 [06]
diagram, the working of disc brakes.

1'(b) Explain briefly the purpose of lubrication. Describe with the help of a suitable CO3 [06]
sketch the full-pressure lubrication system.

2 Explain the working of simple carburettor with the help of neat sketch. Derive an CO5 [12]
expression for air-fuel ratio in spark ignition engines.

OR

2' Discuss various fuel injection systems in diesel engines. CO5 [12]

3(a) Discuss electronic ignition system with a neat sketch. CO5 [06]

3(b) Explain in detail the control mechanisms for spark advance and retard. CO5 [06]
4(a) Explain the working of an automatic clutch with the help of suitable sketch.

4(b) Explain the working of synchromesh gear box with a neat sketch.

5 Discuss various engine steering mechanisms.

OR

5'(a) Discuss the phenomenon of Exhaust gas recirculation (EGR). What are its advantages?

5'(b) Discuss the following terms:

   a) Steering Ratio,
   b) Camber,
   c) Castor.
2018-19
B.TECH. (AUTUMN SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
POWER PLANT ENGINEERING
ME-428

Maximum Marks: 60
Credits: 04
Duration: Two Hours

Answer all the questions.
Assume suitable data if missing.
Marks allotted to each question and course outcome (CO) covered are indicated against each question.
Use of tables and charts is allowed.

Q. No.

1(a) What is geothermal energy? What are different types of geothermal power plants?
     Explain the working of Dry and Flash type geothermal power plant with neat sketch.

1(b) Explain the basic elements of hydro power plant. Also discuss main three criteria
     which should be considered while selecting the site for hydropower plant?

2(a) Explain the working of Babcock and Wilcox Boiler with neat and clean diagram?

2(b) A boiler plant incorporates an economiser and air preheater and generates steam at 40
     bar and 300°C with fuel of heating value 33,000 KJ/kg burned at a rate of 500 kg/h.
     The temperature of feed water is raised from 40°C to 125°C in the economiser and the
     flue gases are cooled at the same time from 395°C to 225°C. The flue gases then enter
     the air preheater in which the temperature of combustion air is raised by 75°C. A
     forced draught fan delivers the air to the air preheater at a pressure of 1.02 bar and a
     temperature of 16°C with a pressure rise across the fan of 180 mm of water. The
     power input to the fan is 5kW and it has a mechanical efficiency of 78%. Neglecting
     heat losses and taking Cp as 1.01 KJ/kgK for flue gases, calculate (a) the mass flow
     rate of air, (b) the temperature of flue gases leaving the plant, (c) the mass flow rate of
     steam and (d) the efficiency of the boiler.

OR

contd....2.
2'(a) With neat sketch, discuss the working of fluidized bed boiler. What are its different types and advantages?

2'(b) Explain the function of economizer in a boiler. A boiler produces 200 kg of dry and saturated steam per hour at 10 bar and feed water is heated by an economiser to a temperature of 110°C. The boiler is fired with coal at 225 kg/hr and having a calorific value of 30100 kJ/kg. If 10% of coal remains unburnt, find (a) the thermal efficiency of the boiler (b) thermal efficiency of the boiler and grate combined.

3(a) Discuss the working of High Temperature Gas Cooled Reactor (HTGR) or Liquid Metal Cooled Fast Breeder Reactor (LMFBR).

3(b) Why are combined cycle power plants not connected in parallel? Derive an expression for three thermal power plants connected in series.

OR

3'(a) Explain the functioning of different components of a nuclear reactor.

3'(b) Derive expressions for estimating the performance parameters of a Boiling Water Reactor (BWR) with a neat sketch.

4(a) What do you mean by power plant economics? Discuss different energy storage methods.

4(b) Differentiate load curve with load duration curve. A power station of 30 MW capacity has the maximum demands of 10 MW, 8.5 MW, 5 MW and 4.5 MW. The annual load factor is 45%. Estimate (a) the average load (b) the energy supplied per year (c) the diversity factor (d) the demand factor.
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.
Draw the vector diagram wherever necessary.

Q.No. Question CO M.M.
1(a) Derive an expression for Euler’s head for a turbo machine. CO1 [04]
1(b) A small Francis turbine has its runner diameter as 50 cm and width at inlet as 8 cm. The restriction coefficient is 0.93. The guide vane angle is 23° and inlet vane angle is 93°. The net head is 60 m, the hydraulic efficiency of the turbine is 98% and overall efficiency is 85%. Find the speed of the turbine and power output. CO3 [08]
2(a) Define different modes of cavitation. Give methods of its prevention. CO3 [06]
2(b) For a propeller turbine the following data is noted,
   i) Velocity from guide vane is 9 m/s,
   ii) Guide vane angle is 30°.
   iii) Velocity of flow at inlet to runner is twice the velocity of flow from guide vane.
   iv) Relation of free vortex exists between the tangential components of the absolute water velocities at exit from guides and inlet to the runner.
   v) The shaft RPM is 150.
vi) Distance from centre of the shaft to the exit of the guides is 3m and that to midway of the blade length is 1.8m.

Find the angle which the relative velocity makes with peripheral direction.

OR

2'(b)  
i) Define undistorted and distorted models and also scale effect.  

ii) Suggest the type of the turbine that should be installed at a dam site where 3.7 MW is to be developed from a single unit under a head of 400m. The designed RPM is 500. If the turbine is tested under a head of 40m, find the power developed and its RPM.

3(a) Answer briefly:  
i) Why radial curve blades are not used in centrifugal pump (CFP).  

ii) Define NPSH for CFP.  

iii) Where non clog impeller of CFP are used.  

iv) Why priming is necessary in CFP.  

v) Write the expression for volumetric efficiency of CFP.  

vi) What is the most important parameter which is responsible for the classification of blades of CFP?

3(b) A centrifugal pump has an impeller of 18 cm outer diameter running at 1440 RPM, discharges water at 10m³/min against a head of 9m. The inner diameter of the impeller is 9cm. The vanes are set back at outlet at 45°, area of flow is constant as 0.06m², find manometric efficiency and vane angle at inlet.

OR

3'(b) With the help of velocity vector diagram develop theoretical head discharge curve for various outlet blade angle of impeller for a centrifugal pump.

4(a) Plot performance characteristics for centrifugal and axial flow compressors and comment on the performance of the two compressor.

4(b) Explain briefly the phenomenon of surging in compressors. An axial flow compressor having eight stages and with 50% reaction design compresses air in the pressure ratio of 4:1. The air enters the compressor at 20°C and flows through it with a constant speed of 90m/s. The rotating blades of compressor are rotate

Contd...
with a mean speed of 180m/s. Isentropic efficiency of the compressor may be taken as 82%. Calculate:
   a) Work done by the machine,
   b) Blade angles.
Assume $\gamma = 1.4$ and $C_p = 1.005$kJ/kg °K.

OR

4'(b) What do you mean by degree of reaction? Air at 24°C flows axially into the eye of impellor of a centrifugal compressor running at 18000rpm and leaves the impellor having a velocity of whirl 0.88 times the velocity of blade tip. The outer diameter of the blade tip is 45cm. Taking isentropic efficiency as 0.75, find:
   a) Rise in temperature of air and
   b) Static pressure ratio.

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

5(b) In a single acting reciprocating pump with plunger diameter of 120mm and stroke of 180mm running at 60rpm. An air vessel is fitted at the same level as the pump at a distance of 3m. The diameter of the delivery pipe is 90mm and the length is 25m. Friction factor is 0.02. Determine the reduction in accelerating head and the friction head due to the fitting of air vessel.

OR

5'(b) What do you mean by hydraulic intensifier? The efficiency of a hydraulic crane which is supplied water under a pressure of 70N/cm² for lifting a weight through a height of 10m is 60%. If the diameter of the ram is 150mm and velocity ratio of 6. Find the weight lifted by the crane and the volume of water required to lift the weight.
2018-19
B.TECH. (AUTUMN SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
NUMERICAL CONTROL OF MACHINE TOOLS (DE)
ME 453

Maximum Marks: 60 Credits: 04 Duration: Two Hours

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

Q.No. Question CO M.M

1 (a) What do you understand by NC coding? Explain the ISO and EIA standard codes for NC coding CO1 [09]

1 (b) Explain the working of any two types of punched tape readers. CO1 [06]

2 (a) Describe the types of electrical drives used for speed and feed control in CNC machine tools. CO2 [09]

2 (b) A DC servomotor is coupled to a lead screw which drives the table of a CNC machine tool. A digital encoder, mounted at the end of the screw, emits 600 pulses per revolution. If the pitch is 7 mm per rev., and the motor rotates 1000 rpm (1:1 gear ratio), calculate the

i) Table speed CO2 [06]

ii) BLU

iii) Frequency of pulses transmitted by the encoder.

OR

2'(a) Describe the principles and purposes of adaptive control. Give some examples of present applications in manufacturing. CO2 [7.5]

2'(b) What are encoders? Explain with the help of neat sketch the working of optical encoders used in CNC machines. CO2 [7.5]

3 (a) What are the parameters required to define and use a "Do Loop" in a part programme. What is the difference between a "Do Loop" and subroutine? CO3 [06]

contd...
3 (b) Write a part programme with the help of G-M codes for the component shown in figure 1. Assume suitable machining data.

RAW MATERIAL: L/H BAR OF DIAMETER 70 M.M.
AND LENGTH 950 M.M.
DIAGRAM NOT TO SCALE.
ALL DIMENSIONS ARE IN M.M.
Figure 1

OR

3' (a) What are fixed cycles? What is the difference between a fixed cycle and a subroutine?

3' (b) Write a subroutine for drilling a series of holes for the workpiece shown in figure 2.

Figure 2

contd...
4 (a) What is computer aided part programming? How is it different from manual part programming?

4 (b) The outline of the component is shown in figure 3 is to be milled using a two flute 10 mm diameter end mill. Write the complete APT program. Inside and outside tolerance should be 0.013 mm. Feed rate = 75 mm/min.; speed = 500 rpm. Postprocessor call statement is MACHIN/MILL_1.

Figure 3 (All dimensions in mm)