**2017-18**

**B. TECH (WINTER SEMESTER) EXAMINATION**

**MECHANICAL ENGINEERING**

**MACHINERY DYNAMICS**

**ME-315**

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>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>For the mechanism shown in Figure-1, determine the required input torque for the static equilibrium of the mechanism. The link dimensions are $AB = 150$ mm, $BC = AD = 500$ mm, $CD = 300$ mm, $CE = 100$ mm and $EF = 450$ mm.</td>
<td>[12]</td>
</tr>
</tbody>
</table>
| 2 (a) | Discuss in brief the following:  
   a) Piston effort and crank effort  
   b) Equivalent offset inertia force  
   c) Coefficient of fluctuation of energy and coefficient of fluctuation of speed of a flywheel. | [06] |
| 2 (b) | The crank and connecting rod of a vertical petrol engine, running at 1800 rpm are 50 mm and 225 mm respectively. The diameter of the piston is 80 mm and the mass of the reciprocating parts is 1.5 kg. During the expansion stroke when the crank has turned $20^\circ$ from the top dead centre, the gas pressure is 700 kPa. Determine  
   i. The net piston force  
   ii. The net load on the gudgeon pin  
   iii. The thrust on the crank shaft bearing  
   iv. The speed at which the load on the gudgeon pin is reversed in direction. | [06] |

**OR**

contd... 2.
2 (b') The turning moment exerted at the crankshaft of a two stroke engine is given by
\[ T = [10000 + 1000 \sin 20 - 3000 \cos 20] \text{ N-m} \]
where "0" is the inclination of the crank from the inner dead centre. A flywheel coupled to the crank shaft has a mass of 600 kg with a radius of gyration 800 mm, the engine rotates at 360 rpm. Determine:-
i. the power developed by the engine,
ii. the total percentage fluctuation of speed, and
iii. the maximum angular acceleration of the flywheel.

3 Four masses A, B, C and D are completely balanced. Masses C and D make angles of at 90° and 210°, respectively with B in the same sense. The planes containing B and C are 300 mm apart. Masses A, B, C and D can be assumed to be concentrated at radii of 360, 480, 240 and 300 mm respectively. The masses B, C and D are 15 kg, 25 kg and 20 kg respectively. Determine the
i) mass A and its angular position.
ii) positions of planes A and D.

OR

3' (a) Why is balancing necessary for rotors of high speed engines? Differentiate between static and dynamic balancing.

3' (b) For an uncoupled two-cylinder locomotive engine with cranks 90° apart, derive expressions for variation in the tractive force, swaying couple and hammer blow.

4 (a) What is a Cam? What type of motion can be transmitted with a cam and follower combination?

4 (b) Draw the profile of a cam operating the exhaust valve of a petrol engine. The displacement diagram of the follower is shown in Fig. 2. The lift of the valve is 36 mm and the least radius of the cam is 50 mm. The radial roller follower is provided with a roller of 40 mm diameter.
Find the maximum velocity and acceleration of the follower during opening and closing periods for a uniform cam shaft speed of 240 rpm. The cam rotates clockwise.
Note: Need not to draw the displacement diagram. Data may be extracted directly form the given displacement diagram shown in Fig. 2.

[6]
4 (b') What are the forces which destablises a four wheel vehicle during turning on the road?

Draw the **condition of stability of a four wheel vehicle during turning**. The weight of the vehicle may be equally distributed on the four wheels and C.G. of the vehicle is to be considered at the middle of the vehicle.

5 (a) What are the advantages of a spring controlled governor over the conventional governor? Mention the name of three prominent spring controlled governor and show the **arrangement of the linkages in a Wilson Hartnell governor** with a neat sketch.

5 (b) Each arm of a **Proell governor** is 300 mm long. The arms are pivoted at 40 mm from the axis of rotation. The sleeve mass is 25 kg and mass of each rotating ball is 3.5 kg. The extension link of the lower arm is vertical and the radius of rotation is 200 mm when the sleeve is in mid-position.

If the governor speed is 160 rpm when the sleeve is in mid-position, find

(i) the length of the extension link

(ii) tension in the upper arm

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**Figure 1**

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**Figure 2**
Q.No. 1  Derive general relations for a chemical reaction between air and fuel in (i) steady flow and (ii) non flow processes. A liquid blend of 80% n-heptane (C_7H_{16}) and 20% methanol (CH_{3}OH) is burned with 400% excess air at 0.1 MPa and 25°C in a steady flow process. Assuming complete combustion, determine the adiabatic flame temperature (show one iteration), A/F ratio on mass and mole basis.

OR

Q. No. 1' A gaseous mixture of 1 kmol of CH₄ and 3 kmol of O₂ contained in a rigid vessel at 1 atm and 25°C is ignited and burns completely (CH₄+3O₂→CO₂+2H₂O_{(g)}+O₂). If the final temperature is 1000 K, determine the final pressure and the heat transferred from the vessel. Assume ideal gas behaviour.

2  Mention advantages of reheat-regenerative cycle. For a reheat-regenerative Rankine cycle, steam enters the turbine at 10 MPa, 500°C. Some steam is bled off at 1 MPa for constant pressure reheating and returned to the turbine at 500°C. After that, a fraction ‘y’ is extracted from the turbine at 0.6 MPa and taken to an open feed water heater (OFWH), which is also at 0.6 MPa. The liquid leaving the OFWH is assumed as saturated liquid at the same pressure. The remaining steam ‘1-y’ is then expanded in the turbine to the condenser pressure of 15 kPa. The feedwater pump placed after the condenser raises the pressure to 0.6 MPa and delivers it to the OFWH, whereas the second pump deployed after the OFWH feeds the water to the boiler at 10 MPa. Assuming isentropic turbine and pump efficiencies respectively as 100%, determine the heat supplied in the boiler. Draw the plant layout and show the resulting cycle on a T-s diagram.
2. Differentiate between boiler and steam generator. In a steam power plant, feedwater enters and leaves the economizer at 150 bar, 30°C and 150 bar, 50°C respectively, then goes to the boiler and exits as dry saturated steam. The steam is then taken to the superheater, where it is superheated to 500°C at the same pressure and goes to the high pressure turbine. A fraction of steam is then bled off from the high pressure turbine at 100 bar with dryness fraction (x=0.88) and supplied to the reheater where it is reheated to 500°C at the same pressure and taken to a low pressure turbine where the steam is expanded to the condenser pressure of 15 kPa, dryness fraction (x=0.88). The steam after getting condensed in the condenser goes to the feedwater pump (FWP). The liquid water leaves the FWP at 150 bar and 30°C and is taken to the economizer to complete the cycle. Show the arrangement/plant layout of the components and calculate the heat transferred in the economizer and boiler.

3. Using relevant relations, draw the curves for property variation with area change for subsonic and supersonic flows, when dp (pressure change) is taken as positive. Discuss the difference in flow characteristics through a conv-div nozzle when the fluid is (i) an ideal gas, (ii) steam.

4. Differentiate between impulse and reaction principles. Two rows of a velocity-compounded impulse turbine have a mean blade speed of 150 m/s and a nozzle velocity of 675 m/s. The nozzle angle is 20°. The exit angles of the first moving row, the fixed row and the second row of moving blades are 25°, 25° and 30°, respectively. There is a 10 percent loss of velocity due to friction in all blades. The steam flow is 4.5 kg/s. Draw the velocity diagram to a suitable scale and determine (a) power output of the turbine, (b) diagram efficiency.

5. Write down energy balance for a mixing (surface) and non mixing (jet) condenser. In an induced type of mechanical cooling tower, water from the condenser enters the tower at 44°C and 5.5 kg/s. The induced draft fan (at the top) induces 9m³/s of outside air at 18°C and 60% RH and air leaving the tower is assumed saturated at 26°C. Pressure is constant equal to 1.013 bar. If the power consumed is 4.75 kW, determine (i) the make up water rate in kg/s and (ii) write down the energy balance for the tower (no calculation is required).
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. | Question | M.M.
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1(a) | What are the main constituents of exhaust emissions from petrol engines? Classify IC engines on the basis of (i) Type of Ignition (ii) Engine Cycle (iii) Position and number of cylinders (iv) Applications. | [6]
1(b) | A 6-cylinder, gasoline engine operates on the four stroke cycle. The bore of each cylinder is 80 mm and the stroke is 100 mm. The clearance volume per cylinder is 70 cc. At a speed of 4000 rpm the fuel consumption is 20 kg/h and the torque developed is 150 Nm. Calculate (i) the brake power (ii) the brake mean effective pressure (iii) brake thermal efficiency if the calorific value of the fuel is 43000 kJ/kg (iii) The relative efficiency on a brake power basis assuming the engine works on the constant volume cycle. Take Y=1.4 for air. | [6]
2(a) | Discuss actual exhaust process. Obtain an expression for intake gas temperature before compression. | [4]
2(b) | Find the percentage change in the efficiency of a CI engine having a compression ratio of 16 and cut-off ratio is 10% of the swept volume, if the C_v increases by 2%. Take γ = 1.4, C_v = 0.717 kJ/kgK. | [8]

OR

2'(a) | How does an actual cycle differ from a Fuel-air cycle? Discuss the effects of various losses encountered in an actual cycle. | [4]
2'(b) | The A/F ratio of a diesel engine is 29:1. If the compression ratio is 16:1 and the temperature at the end of the compression is 900 K, find at what cylinder volume the combustion is complete? Express this volume as a percentage of stroke. Assume that the combustion | [8]
begins at TDC and takes place at constant pressure. Take calorific value of fuel as 42 MJ/kg, \( R = 0.287 \text{ kJ/kgK} \) and \( C_v = 0.709 + 28 \times 10^{-6} \text{ T kJ/kgK} \).

3(a) Classify solid injection systems. Discuss the working of Individual pump and nozzle system.

3(b) It is required to design a 4-stroke CI engine to operate with following characteristics at sea level where the temperature is 10°C and pressure is 1.03 bar.

- B.P. = 250 kW, Volumetric efficiency = 78%, Specific fuel consumption = 0.245 kg/kWh,
- A/F ratio = 17:1, Speed = 1500 rpm

Determine the required engine capacity and brake mean effective pressure. A supercharger is then fitted to the engine so that it may be operated at an altitude of 2700 m where pressure is 0.72 bar. The supercharger consumes 8% of engine power and the temperature of air leaving the supercharger is 32°C. Calculate the increase of air pressure required at the supercharger to maintain same net output of 250 kW. Assume that the A/F ratio, volumetric efficiency and thermal efficiency remain the same for the supercharged engine as when running unsupercharged engine at sea level.

4(a) Explain the phenomenon of Detonation in SI engines. Discuss the effect of various engine variables on detonation.

4(b) Explain the normal combustion phenomena in CI engines by specifying various stages of combustion. Also discuss the variables which affect the delay period in these engines.

5(a) Draw the schematic diagram and explain the functioning of liquid bi-propellant rocket engines using pump feed and pressure feed systems. Mention some of the commonly used liquid propellants.

5(b) In an ideal gas turbine cycle with reheat, air at state \((p_1, T_1)\) is compressed to pressure \(p_r\) and heated to \(T_3\). The air is then expanded in two stages, each turbine having the same pressure ratio, with reheat to \(T_3\) between the stages. Assuming the working fluid to be a perfect gas with constant specific heats, and that the compression and expansion are isentropic, show that the specific output will be a maximum when \( r \) is given by

\[
r^{(r-1)/r} = \left(\frac{T_3}{T_1}\right)^{3/2}
\]

OR

5'(a) Discuss the effects of compressor inlet temperature, turbine inlet temperature and pressure ratio on the thermal efficiency of a simple gas turbine cycle.

5'(b) A jet aircraft is flying with a velocity of 965 km/h at an altitude of 12.2 km, where the pressure is 20 kPa and the temperature is 220 K. The air enters an ideal diffuser and leaves the combustor at 1350 K and 100 kPa. The fuel has a heating value of 43 MJ/kg. All expansion and compression processes are isentropic. Determine the (i) compressor work (ii) fuel-air ratio (iii) pressure entering the nozzle (iv) specific thrust (v) propulsive efficiency (vi) thermal efficiency (vii) total thrust for an air flow of 32 kg/s.
2017-18
B.TECH. (WINTER SEMESTER) EXAMINATION
MANUFACTURING TECHNOLOGY II
ME 325

Maximum Marks: 60
Credits: 04
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Answer all the questions.
Assume suitable data if missing.

1(a) Find the tool life for the minimum cost per piece in single pass turning given:
    a = machining rate including labour and overhead.
    b = tool cost per cutting edge
    t = tool changing time
    n = exponent in Taylor’s tool life equation
    C = constant in Taylor’s tool life equation
Make any valid assumptions with justification.

1(b) In a metal cutting experiment, the tool lives were found to vary with cutting speed in the following manner:

<table>
<thead>
<tr>
<th>Cutting speed, V, m/min</th>
<th>Tool life, T, min</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>120</td>
</tr>
<tr>
<td>130</td>
<td>50</td>
</tr>
</tbody>
</table>

Derive the Taylor’s tool life equation for this operation and estimate the tool life at a speed of 2.5 m/s. Also estimate the cutting speed for a tool life of 80 minutes.

OR

1'(b) Using Merchant’s cutting mechanics analysis, derive a relationship between the shear energy and friction energy in term of the rake angle, shear angle and friction angle.

2(a) Give similarities and differences among shaping and planning machines with respect to constructional features, applications and working.

2(b) The flat surface of a large cast-iron part measuring 1 m x 0.3 m x 300 mm is to be machined using a planer along its face (1 m x 0.5 m). Take cutting speed as 20 m/min, return speed as 40 m/min and feed as 1 mm/ stroke. Neglect the over-travel and approach distances in calculating the planning time. Assume the time for reversing the table as 0.02 minutes. Calculate the time required to machine.

OR

cont'd...
2'(a) What is honing? Discuss the honing process in detail. Explain the parameters which affects the honing processes. Enumerate the defects which may be caused due to improper honing.

2'(b) What do you understand by jigs and fixtures? Differentiate between a jig and a fixture. A slot of 10 mm x 5 mm on the face of 900 mm x 600 mm x 20 mm E16 steel part is to be cut on a milling machine. Design a fixture for its mass production.

3(a) Explain the following with reference to CNC systems:
   i. Tool pre-setting
   ii. Absolute and incremental dimensioning

3(b) A product given in figure below is to be produces from a stock of 50 mm diameter on a CNC lathe. Write a required G-M part program.

![Drilling/Reaming Diagram]

4(a) Differentiate between local interchangeability and universal interchangeability. Discuss the importance of preferred numbers in universal interchangeability.

4(b) For a fit designated by 25H8d9, calculate the allowance and classify the type of fit. Also design inspection grade GO and NO-GO gauge for it, given that:
   25 mm falls in the diameter step of 18 mm to 30 mm
   Fundamental deviation of d shaft = 16 D^-0.44
   IT8 = 25 i; IT9 = 40 i

OR

4'(a) Describe how rollers balls and slip gauges may be used to measure the angle of taper plug gauge and taper ring gauge.

Calculate the taper angle of an internal taper from the following readings:
   Diameter of the bigger ball = 10.25 mm
   Diameter of smaller ball = 6.07 mm
   Height of top of bigger ball from bottom surface = 30.10 mm
   Height of top of smaller ball from bottom surface = 10.08 mm

4'(b) Give reasons for the following:
i. Least number of slip gauges should be used to build up a required dimension.

ii. C.I. is preferred material for surface plates

iii. Sine bar is not used for angles more than 45°

5 Answer any TWO of the following:

a. i. Discuss the difference between alignment tests and performance tests.

ii. Explain the method of comparing the height of a slip gauge against a standard using an optical flat. Two slip gauges of 10 mm width measuring 1.000 mm and 1.002 mm are kept side by side in contact with each other length wise. An optical flat is kept on the slip gauges. Monochromatic light of wavelength 0.0058928 mm is used. Calculate the total number of fringes that will be observed on both slip gauges.

b. What is the best size wire for screw thread measurement? Derive the expression for the same. Calculate the best size wire for an M20 X 25 screw.

c. Describe the constant chord method for the measurement of tooth thickness. What are its advantages over chordal thickness method?
Answer all the questions. Assume suitable data if missing. Notations used have their usual meaning. Use of Mathematical Formula Sheet and Compressible flow charts are allowed.

Q.No. | M.M. | [06]
--- | --- | ---
1(a) | A 1/25 scale model of a submarine is being tested in a wind tunnel in which $p = 200$ kPa and $T = 300$ K. If the prototype speed is 30 km/hr, what should be the freestream velocity in the wind tunnel? What is the drag ratio? Assume that the submarine would not operate near the free surface of the ocean.

1(b) | The temperature ‘$T$’ is known to vary along the length of a long tunnel as $T = T_0 - \alpha \sin \left(2\pi \frac{x}{L}\right) e^{-\tau}$ where $T_0, \alpha, \tau, L$ are constants and $x$ is measured from the tunnel entrance. A fluid particle moves in the tunnel given as $\vec{V} = U_0 t$, where $U_0$ is a constant. Obtain the general expression for the time rate of change of temperature experienced by the particle.

2 | [03X4] | Describe the following:
   i. Boundary Layer thickness
   ii. Displacement thickness
   iii. Momentum thickness
   iv. Shape factor

OR

2' | Derive the boundary Layer Equations for Zero Pressure Gradient over a flat plate. [12]

3 | Describe Reynolds description of turbulent flow and use it to derive Reynolds Averaged Navier Stokes Equation. [12]

OR

3' | Describe physical properties of Turbulent flow and the closure problem in turbulence. [12]

cont'd... 2
4(a) Air is expanded from a convergent-divergent nozzle from a large reservoir in which the pressure and temperature is 500 kPa and 45°C, respectively. The design back pressure is 100 kPa (γ = 1.4, R = 287 kJ/kg K). Find:
(i) The ratio of nozzle exit area to the throat area
(ii) The discharge velocity from the nozzle under design conditions
(iii) At what back pressure will there be a normal shock at the exit plane of the nozzle?

4(b) The pressure ratio across a normal shock wave that occurs in air is 1.5. Ahead of the shock wave, the pressure is 100 kPa and the temperature is 15°C. Find the velocities ahead and behind the stationary shock wave. Also find the pressure and temperature behind the shock wave.

5(a) Air is flowing over a flat wall. The Mach number, pressure, and temperature in the air-stream are 3, 50 kPa, and -20°C respectively. If the wall turns through an angle of 5° leading to the formation of an oblique shock wave, find the Mach number, the pressure and the temperature in the flow behind the shock wave.

5(b) Air flows in a 6 cm diameter pipe. The air enters at M = 2.5 and is to leave at M = 1.5. What length of pipe is required? What length of pipe would give sonic flow at exit? Assume f = 0.002 and that the flow is adiabatic.

OR

5'(a) Air flowing at a Mach number of 2.5 passes over a wedge that turns the flow through an angle of 6°. Find the pressure ratio across the oblique shock generated. If this oblique shock is reflected at a plane surface, find the overall pressure ratio.

5'(b) Air at a temperature of 100°C with a pressure of 101 kPa enters a constant area duct at a velocity of 130 m/s. Determine:
(i) The maximum amount of heat that can be transferred to the air flow per unit mass of air.
(ii) The maximum temperature that can be attained by transfer of heat to the air.
1(a) A new building to house Manufacturing Facilities is to be constructed on the campus to strengthen income generation. A design utilizing a combination earth-work bowl with a steel upper deck and press box is being considered. The following cost estimates (in $) have been developed:

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>First cost of complete construction</td>
<td>32,000</td>
</tr>
<tr>
<td>Paint steel structure every 6 years</td>
<td>2,000</td>
</tr>
<tr>
<td>Replace iron grouting’s every 10 years</td>
<td>4,000</td>
</tr>
<tr>
<td>Repave machine foundations every 12 years</td>
<td>3,000</td>
</tr>
<tr>
<td>Annual Maintenance</td>
<td>1,500</td>
</tr>
</tbody>
</table>

Assuming 25-year life and negligible salvage value, determine the minimum annual revenue that must be generated to justify the project when the interest rate is 7%.

1(b) What are economic indicators? Explain GDP and GNP.

OR

1’ There is a continuing requirement for standby electrical power at a public utility service facility. Equipment alternative “S1” involves an initial cost of $72,000, a 9 year useful life, annual expenses of $2,200 the first year and increasing $300 per year thereafter, and the net market value of $8,400 at the end of the useful life. Alternative “S2” has an initial cost of $90,000, a 12 year useful life, annual expenses of $2,100 the first year and increasing at the rate of 5% per year thereafter, and a net market value of $13,000 at the end of useful life. The current interest rate is 10% per year. Which alternative is preferred using Present Worth method?

contd....2.
A company is considering replacing 15 workstations which are on a STAR network. These workstations have a total salvage value of $8500. The existing system could last for another 3 years with a system update that will cost $4500 immediately. Also, after the update, the current system will have the following associated data:

<table>
<thead>
<tr>
<th>Year</th>
<th>Salvage value($)</th>
<th>Operating &amp; Maintenance Costs ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7000</td>
<td>13000</td>
</tr>
<tr>
<td>2</td>
<td>3500</td>
<td>18000</td>
</tr>
<tr>
<td>3</td>
<td>1000</td>
<td>23000</td>
</tr>
</tbody>
</table>

The new workstations will cost $8000 each ($8000\times15$=$120,000 in total), and implementation for all the computers will cost $1500. The technological life of the new equipment is 5 years and salvage value decreases from the first cost by 28% per year. Operating costs will be $4000 for each of the first 2 years (due to warranty issues) and will be $8000, $10000, and $13000 for years 3 through 5 respectively. Should the company opt for replacement? If so, when? Use MARR of 8% per annum.

2(b) Define Inflation. Discuss some causes and consequences of inflation.

3(a) What activities do managers perform under the four major functional areas of management?

3(b) Illustrate with an example the use of payoff matrix in decision making.

4(a) Explain various levels of planning in the context of a university as an organization.

4(b) Briefly explain the five different kinds of leaders on the leadership grid.

OR

4'(a) Discuss the relative merits and demerits of Product and Functional forms of Departmentalization.

4'(b) Differentiate between (i) Flat and Tall organizational structures (ii) Power and Authority

5(a) Why do companies hold inventory? What factors discourage them to hold inventory beyond a certain level?

5(b) Briefly explain three major decision areas of financial management.