2018-19
B. TECH. (AUTUMN SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
HIGHER MATHEMATICS
AM-231

Maximum Marks: 60 Credits: 04 Duration: Two Hours

Answer all questions.
Notations and symbols used have their usual meaning.
Marks allotted to each question and course outcome (CO) covered are indicated against each question.

Q.No.  Question                                    CO  M.M.
1(a)    Find the Laplace transform of \( t \int_0^t e^{-4t} \sin 3t \, dt \). (CO1) [07]

OR

1(a')   Find the inverse Laplace transforms of the following functions.

(i) \( \frac{4s + 5}{(s - 1)^2(s + 2)} \) (ii) \( \frac{6 + s}{s^2 + 6s + 13} \) (CO1) [07]

1(b)    Using Laplace transform, find the solution of initial value problem

\[ \frac{dy}{dt} + y = \cos 2t, \quad y(0) = 1. \] (CO1) [08]

2(a)    Find the directional derivative of \( \phi = x^2 - y^2 + 2z^2 \) at the point \( P(1, 2, 3) \) (CO2) [07]
in the direction of the line \( PQ \), where \( Q \) is the point \( (5, 0, 4) \). In what
direction will it be maximum? Find the maximum value of it.

OR

2(a')   Prove that \( \text{div} (\text{grad } r^n) = n(n + 1)r^{n-2} \), where \( \vec{r} = x\hat{i} + y\hat{j} + z\hat{k} \). (CO2) [07]

2(b)    Show that the vector field \( \vec{v} = (y^2 - x^2 + y)i + x(2y + 1)j \) is irrotational
and find a scalar function \( f \) such that \( \vec{v} = \text{grad } f \). (CO2) [08]

3(a)    Find the work done by the force \( \vec{F} = -xy\hat{i} + y^2\hat{j} + z\hat{k} \) in moving a particle
over the circular path \( x^2 + y^2 = 4, z = 0 \) from \( (2, 0, 0) \) to \( (0, 2, 0) \). (CO3) [07]

Contd...
3(b) Verify divergence theorem for \( \vec{F} = 4xz\hat{i} - yj + yz\hat{k} \) taken over the cube bounded by the planes \( x = 0, x = 1, y = 0, y = 1, z = 0, z = 1. \) \[ \text{(CO3) [08]} \]

OR

3(b') Use Stoke's theorem to evaluate the integral \( \int_S (\nabla \times \vec{F}) \cdot \hat{n} \, dS \) taken over the upper portion of the surface \( x^2 + y^2 - 2ax + az = 0 \) and the bounding curve lies in the plane \( z = 0, \) when \( \vec{F} = (y^2 + z^2 - x^2)\hat{i} + (z^2 + x^2 - y^2)\hat{j} + (x^2 + y^2 - z^2)\hat{k}. \)

4(a) Define analytic function. Show that the function

\[
    f(z) = \begin{cases} 
    \frac{xy^2(x + iy)}{x^2 + y^2}, & z \neq 0 \\
    0, & z = 0
    \end{cases}
\]

is not analytic at the origin although C-R equations are satisfied at the origin.

OR

4(a') Show that \( u(x, y) = e^x(x \cos 2y - y \sin 2y) \) is harmonic. Find the harmonic conjugate function \( v(x, y) \) and the corresponding analytic function \( f(z) = u + iv \) in terms of \( z. \)

4(b) (i) Evaluate \( \int_C |z| \, dz, \) where \( C \) is the left half of the unit circle \( |z| = 1 \) from \( z = -i \) to \( z = i. \)

(ii) Use Cauchy's integral formula to evaluate

\[
    \int_C \frac{3z^2 + z}{z^2 - 1} \, dz,
\]

where \( C \) is the circle \( |z| = 2. \)
2018-19
B.TECH. (AUTUMN SEMESTER) EXAMINATION
(MECHANICAL ENGG.)
HIGHER MATHEMATICS
AMS-2310

Maximum Marks: 60  Credits: 04  Duration: Two Hours

Note: (i) Attempt all questions.
(ii) Symbols have their usual meanings.
(iii) Marks allotted to each question and course outcome (CO) covered are indicated against each question.

**Q.No.**  **Question**  **CO**  **Marks**
1(a)  Prove that the function $f(z)$ defined by $f(z) = \frac{x^3(1+i) - y^3(1-i)}{x^2 + y^2}$, $z \neq 0$, $f(0) = 0$, satisfies the Cauchy-Riemann equation at the origin, yet $f'(0)$ does not exist.  CO1  [07]
1(b)  Evaluate the integral $\int_{0}^{2+i} z^2 \, dz$, along (i) the line $x = 2y$ (ii) the real axis to 2 and then vertically to $2 + i$.  CO1  [08]

**OR**

1(b')  State Cauchy's Integral Theorem and evaluate the following integral using Cauchy's Integral Formula $\int_{C} \frac{e^z}{z^2(z+1)^3} \, dz$, $C : |z| = 2$.  CO1  [08]

2(a)  Find all possible Taylor's and Laurent series expansion for the functions $f(z) = \frac{1}{1-z}$ about $z = 0$.  CO2  [07]

**OR**

2(a')  Using Residue theorem evaluate $\int_{C} \frac{(z-3)}{(z^2+2z+5)} \, dz$, where $C$ is the circle

(i) $|z + 1 - i| = 2$  (ii) $|z + 1 + i| = 2$.

2(b)  Evaluate $\int_{0}^{\infty} \frac{\cos ax}{x^2+1} \, dx$.  CO2  [08]

3(a)  Find the directional derivative of $\varphi(x,y,z) = x^2y^2z^2$ at the point $(1, 1, -1)$ in the direction of the tangent to the curve $x = e^t, y = \sin 2t + 1, z = 1 - \cos t$ at $t = 0$.  CO3  [07]

3(b)  Let $\vec{r} = xi + yj + zk$, $r = |\vec{r}|$ and $\vec{a}$ is a constant vector. Find the value of

$$div \left( \frac{\vec{a} \times \vec{r}}{r^n} \right)$$

**OR**

**contd...2.**
3(b') Show that the vector field \( \vec{F} = (2xy + z^3)\hat{i} + x^2\hat{j} + 3xz^2\hat{k} \) is conservative. Find its scalar potential and the work done in moving a particle from \((1, -2, 1)\) to \((3, 1, 4)\).

4(a) Evaluate \( \int \vec{F} \cdot d\vec{s} \) where \( \vec{F} = 4xi - 2y^2\hat{j} + z^2\hat{k} \) and \( S \) is the surface bounding the region \( x^2 + y^2 = 4, z = 0 \) and \( z = 3 \).

OR

4(a') Evaluate \( \oint_C \vec{F} \cdot d\vec{r} \) by Stoke's Theorem, where \( \vec{F} = y^2\hat{i} + x^2\hat{j} - (x + z)\hat{k} \) and \( C \) is the boundary of the triangle with vertices at \((0,0,0)\), \((1,0,0)\) and \((1,1,0)\).

4(b) Verify Green's theorem for \( \int_C [(xy + y^2) \, dx + x^2 \, dy] \), where \( C \) is bounded by \( y = x \) and \( y = x^2 \).
1(a) Describe ‘aspiration effect’ in sand casting.  

1(b) Develop a relation between the cross-sectional area of the down sprue and its height to avoid aspiration effect in sand casting.  

1(c) Suggest a suitable moulding process to manufacture the body of an electric motor (a figure is given below). Justify your suggestion. Discuss each stage in detail with the help of neat sketches:  

1(d) Discuss shake out of sand castings.  

2(a) With the help of sketches differentiate between shielded metal arc welding (SMAW) and gas metal arc welding (GMAW) techniques.  

2(b) Compute the welding speed while performing a square butt welding during the fabrication of mid steel pipe from sheet 20 mm thick through GMAW. Assume specific energy of mild steel as 10.0 J/mm², supply voltage = 20 V and current = 500 A.  

2(c) Differentiate between brazing and soldering process of joining. Discuss the joining of various components of a heat exchanger.  

OR  

2'(a) Compare the strength of solid phase welded joint with the strength of the metallic bound.  

2'(b) Discuss the advantages of flash welding (FW) over solid phase butt welding.
2(c) Two titanium strips of cross-section 15 mm x 20 mm are to be joint through FW with a flash of 1 mm each. Compute the current required if the supply voltage is 10 V. Assume the specific energy of titanium = 14.0 J/mm³. Take the welding efficiency as 70%.

3(a) With the help of a neat sketch define the length of contact in rolling a strip of rectangular cross-section.

3(b) Derive an expression to compute the length of contact for rolling a mild steel strip.

3(c) Define extrusion ratio.

3(d) Calculate the extrusion force to produce wire of 3.0 mm diameter from a stock of 15 mm diameter brass. Assume yield stress of brass = 900 MPa.

OR

3'(a) Derive an expression to calculate the stress to forge a long rectangular brass strip.

3'(b) Calculate the force required to forge a brass strip of 500 mm x 30 mm x 20 mm to 500 mm x 40 mm x 15 mm. Flow stress for brass can be calculated from the equation \( \sigma = K \varepsilon^n \). And the value of \( K \) and \( n \) can be assumed as 900 MPa and 0.5 respectively.

3'(c) Discuss spring back effect in bending.

4(a) Discuss composite materials. Give the classification of composite materials.

4(b) A 25 mm diameter rod is made of 80% steel homogeneously dispersed with the particles of 15% Al₂O₃ and 5% SiC. Compute the density of the composite. Assume the relative density of steel, Al₂O₃ and SiC as 8.1, 4.0 and 3.21 respectively.

OR

4'(a) Discuss selective laser sintering.

4'(b) Define thermo-plastics and thermosets.

4'(c) Explain manufacturing of water bottles through blow moulding. Give neat sketches of each stages.

5(a) With the help of neat sketches discuss the following processes. Also discuss their application:
   (a) Electro chemical machining
   (b) Ultra sonic machining
2018-19  
B.Tech. (AUTUMN SEMESTER) EXAMINATION  
MECHANICAL ENGINEERING  
EXPERIMENTAL METHODS AND ANALYSES  
ME-220/MEA-2420

Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

Answer all the questions.  
Assume suitable data if missing.  
Use of statistical tables is allowed.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
</table>
| 1.    | a) A recreational equipment supplier finds that among orders that include tents, 40% also include sleeping mats. Only 5% of orders that do not include tents do include sleeping mats. Also, 20% of orders include tents. Determine the following probabilities:  
(i) The order includes sleeping mats.  
(ii) The order includes a tent, given it includes sleeping mats.  

b) The following distribution is given  
\[ x \quad 1.25 \quad 1.5 \quad 1.75 \quad 2 \quad 2.25 \]  
\[ f(x) \quad 0.2 \quad 0.4 \quad 0.1 \quad 0.2 \quad 0.1 \]  
Calculate:  
(i) P(X ≥ 2)  
(ii) P(X < 1.65)  
(iii) P(X = 1.5)  
(iv) P(X < 1.3 or X > 21)  

c) The phone lines to an airline reservation system are occupied 40% of the time. Assume that the events that the lines are occupied on successive calls are independent. Assume that 10 calls are placed to the airline. 
(i) What is the probability that for exactly three calls, the lines are occupied? 
(ii) What is the probability that for at least one call, the lines are not occupied? 
(iii) What is the expected number of calls in which the lines are all occupied?  

1'. a) The thickness of wood panelling (in inches) that a customer orders is a random variable with the following cumulative distribution function:  
\[ F(x) = \begin{cases} 
0 & x < 1/8 \\
0.2 & 1/8 \leq x < 1/4 \\
0.9 & 1/4 \leq x < 3/8 \\
1 & 3/8 \leq x 
\end{cases} \]  
Determine the following probabilities:  
(i) P(X ≤ 1/18)  
(ii) P(X ≤ 1/4)  
(iii) P(X ≤ 5/16)
b) An electronic office product contains 5000 electronic components. Assume that the probability that each component operates without failure during the useful life of the product is 0.999, and assume that the components fail independently. Approximate the probability that 10 or more of the original 5000 components fail during the useful life of the product.

c) Let X denote the number of times a certain numerical control machine will malfunction: 1, 2, or 3 times on any given day. Let Y denote the number of times a technician is called on an emergency call. Their joint probability distribution is given as

\[
\begin{array}{c|ccc}
   & 1 & 2 & 3 \\
---&---&---&---
1 & 0.05 & 0.05 & 0.1 \\
2 & 0.05 & 0.1 & 0.35 \\
3 & 0 & 0.2 & 0.1 \\
\end{array}
\]

(i) Evaluate the marginal distribution of X.
(ii) Evaluate the marginal distribution of Y.
(iii) Find \( P(Y = 3 \mid X = 2) \).

2. a) Find the following:
   (i) \( \chi^2_2 \) if, \( \text{Prob}(\chi^2 < \chi^2_2) = 0.95 \) when \( \nu = 6 \);
   (ii) \( \text{Prob}(t_{0.005} < t < t_{0.01}) \) for \( \nu = 19 \).
   (iii) \( f_{0.99} \) with \( \nu_1 = 19 \) and \( \nu_2 = 24 \);

   b) The titanium content in an aircraft-grade alloy is an important determinant of strength. A sample of 20 test coupons reveals the following titanium content (in percent):
   
   8.32, 8.05, 8.93, 8.65, 8.25, 8.46, 8.52, 8.35, 8.36, 8.41, 8.42,
   8.30, 8.71, 8.75, 8.60, 8.83, 8.50, 8.38, 8.29, 8.46

   The mean titanium content should be 8.5%.
   Use the sign test with \( \alpha = 0.05 \) to investigate the hypothesis \( H_0 : \mu = 8.5 \) versus \( H_1 : \mu \neq 8.5 \). Find the \( p \)-value for this test.

3. a) (i) What is impedance loading? Why it can’t be zero? Name different type of dynamic inputs to the system. (ii) A temperature measuring system, with a time constant of 1s, is used to measure temperature of a heating medium, which changes sinusoidally between 250 and 200°C with a periodic time of 10s. Find the maximum and minimum values of temperature, as indicated by the measuring system and the time lag between the output and input signals.

   b) Obtain the solution for first order system with a sinusoidal input and discuss the frequency response.

   OR

b') What is step input? Obtain the solution for a first order system with step input and discuss the frequency response.
4. a) Why automatic reference junction compensation (ARJC) is employed in the thermocouples. What is the property of LED's? Name commonly use LED material for emitting green and yellow lights.

b) Derive expression for Gauge Factor of a strain gauge. Why is the Gauge Factor of strain gauges made of semiconductor material much higher than those made of metal? A strain gauge having an unrestrained resistance of 120 Ω and a gauge factor of 2.1 is bonded onto a steel girder so that it experiences a tensile stress of $10^8$ Pa. If Young's modulus for steel is $2 \times 10^{11}$ Pa, calculate the strained resistance of the gauge.

OR

b') Classify data presentation elements. What digital display principles are used for character and graphic display. Explain the working of Prony brake dynamometer.
Maximum Marks: 60

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

Q.No. Question

1(a) A rectangular steel bar having a cross-section 2 cm × 3 cm is subjected to a tensile force of 6 kN. If the axes are chosen as shown in Fig. 1, determine the normal and shear stresses on a plane whose normal has the following direction cosines:
   i. \( n_x = n_y = \frac{1}{\sqrt{2}}, n_z = 0; \)
   ii. \( n_x = 0, n_y = n_z = \frac{1}{\sqrt{2}} \)
   iii. \( n_x = n_y = n_z = \frac{1}{\sqrt{3}} \)
Show the above plane in Fig. 1.

1(b) For the state of stress shown in Fig. 2, determine the range of values of \( \tau_{xz} \) for which the maximum shearing stress is equal to or less than 60 MPa.

1(c) Explain hydrostatic state of stress and the state of pure shear. The state of stress characterised by \( \tau_{ij} \) is given below.

\[
\tau_{ij} = \begin{bmatrix} 10 & 4 & 6 \\ 4 & 2 & 8 \\ 6 & 8 & 6 \end{bmatrix}
\]

Resolve the given state into a hydrostatic state and a pure shear state. Determine the normal and shearing stresses on an octahedral plane. Compare...
these with the $\sigma_{oct}$ and $\tau_{oct}$ calculated for the hydrostatic and the pure shear states. For the octahedral planes of the given state, the hydrostatic state and the pure shear state are same or are they different? Explain why.

OR

1'(a) State and explain generalized Hook's Law for isotropic materials. A cubical element is subjected to the following state of stress.

$$\tau_{ij} = \begin{bmatrix} 18 & 0 & 24 \\ 0 & -50 & 0 \\ 24 & 0 & -32 \end{bmatrix} \text{ MPa}$$

Determine the extremum values of shear strains and the octahedral shear strain, if Young's modulus $E = 2 \times 10^5 \text{ MPa}$ and Poisson's ratio $\nu = 0.25$.

1'(b) The strains determined using the strain rosette shown in Fig. 3 during the test of a machine are given by $\varepsilon_1 = 800\mu$, $\varepsilon_2 = 550\mu$, $\varepsilon_3 = -100\mu$

Determine (a) $\varepsilon_x$, $\varepsilon_y$ and $\gamma_{xy}$, in-plane principal strains, and in-plane maximum shearing strain.

2.(a) Explain the validity of Euler's buckling theorem. Derive expression for Euler's buckling load for a thin column having fixed-free end conditions.

2.(b) State and explain Castigliano's first theorem. Determine the vertical displacement of the point of application of force $P$. Take all energies into account. The member is of uniform circular cross-section

---

2 Contd... 3.
3.(a) What are important considerations, assumptions and applications of thin cylindrical pressure vessel? Establish a relationship between wall thicknesses corresponding to cylindrical and hemispherical parts in a cylindrical pressure vessel with hemispherical ends.

3.(b) A cylindrical pressure vessel 10 m long has closed ends, a wall thickness of 5 mm, and a diameter at mid-thickness of 3 m. If the vessel is filled with air to a pressure of 2 MPa, how much do the length, diameter, and wall thickness change, and in each case state whether the change is an increase or a decrease. The vessel is made of a steel having elastic modulus $E = 200 \, GPa$ and the Poisson’s ratio $\nu = 0.3$. Neglect any effects associated with the details of how the ends are attached.

OR

3.(b') The internal and external diameters of a thick hollow cylinder are 80 mm and 120 mm respectively. It is subjected to an external pressure of 40 N/mm$^2$ and an internal pressure of 120 N/mm$^2$. Calculate the following
(i) Hoop and radial stresses at the inner, outer and mean radii.
(ii) Sketch the distribution of stresses across the thickness.

4.(a) State and explain any two of the following:
(i) Wire-wound thin cylinders. Derive the stress strain relations for the same.
(ii) Compound cylinder
(iii) Clapeyron’s three moment theorem.

4.(b) Determine the reactions at the support and maximum deflection $\delta$ in the beam as shown in Fig. 5 carrying a uniformly distributed load of intensity 60 kN/m. 60 kN/m

![Fig. 5](image-url)
2018-19  
B. TECH. (AUTUMN SEMESTER) EXAMINATION  
MECHANICAL ENGINEERING  
KINEMATICS OF MACHINE  
MEC-2120

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>
<th>CO</th>
</tr>
</thead>
</table>
| 1 (a) | Differentiate giving examples:  
  i) Lower and higher pair  
  ii) Exact and approximate straight line motion mechanism  
  iii) Whitworth quick return and crank and slotted lever quick return motion mechanisms. | 09 | CO1 |
| 1 (b) | Derive an expression for the ratio of angular velocities of the shafts of a Hooke’s joint. | 06 | CO1 |
| 1’ (a) | In a Davis steering gear, the length of the car between axles is 2.4 m and the steering pivots are 1.35 m apart. Determine the inclination of track arms to the longitudinal axis of the car when the car moves in a straight path. | 07 | CO1 |
| 1’ (b) | Discuss in brief:  
  i) Kutzbach’s criterion for degree of freedom of a plane mechanism.  
  ii) Inversions of double slider-crank-chain mechanism (Classification only).  
  iii) Redundant link in a mechanism.  
  iv) Grashof’s criterion. | 08 | CO1 |
| 2 | For the toggle mechanism shown in Figure 1, determine the velocities and accelerations of slider at D, when the crank rotates at 240 rpm in clockwise direction. | 15 | CO2 |
2' (a) Discuss in brief:

i) Kennedy's theorem as applicable to instantaneous centre of rotation of three bodies.

ii) Type and number of instantaneous centres in a "n" link mechanism.

2' (b) An engine crank shaft drives a reciprocating pump through a mechanism as shown in Figure 2. The angular velocities of different links are: \( \omega_{oa} = 16.76 \text{ rad/s} \) clockwise, \( \omega_{ba} = 3.77 \text{ rad/s} \) clockwise, \( \omega_{bc} = \omega_{cd} = 3.35 \text{ rad/s} \) counter clockwise. Determine the velocities of rubbing at A, B and C if the diameter of the pins at A, B and C are 40, 30 and 30 mm, respectively.

2' (c) In a reciprocating engine mechanism, derive an expression for velocity and acceleration of the piston, if the length of connecting rod is "l", radius of the crank is "r" and the crank angle is "\( \theta \)".

3 (a) Discuss in brief the classification of synthesis problems.

3 (b) Synthesize a four bar function generator to solve the equation

\[ y = \frac{1}{x} ; 1 \leq x \leq 3 \]

using Chebyshev spacing for three precision points based on Freudenstein's method. Take \( \phi_0 = 30^\circ \), \( \psi_0 = 200^\circ \), \( \Delta \phi = \Delta \psi = 90^\circ \).

4 (a) A reverted gear train shown in Figure 3 is used to provide a speed ratio of 10. The module of the gears 1 and 2 is 3.2 mm and of gears 3 and 4 is 2 mm. Determine the suitable numbers of teeth for each gear. No gear is to have less than 20 teeth and the centre distance between the shafts is 160 mm.

4 (b) What is meant by gear train? Give their brief classification with suitable examples.
Figure 1

Figure 2

Figure 3
2018-2019
B. TECH. III Semester Examination
(Mechnical)
Fluid Mechanics -I
(MEC-2310/ME-231)

Maximum Marks: 60
(Credits: 04)
Duration: Two Hours

NOTE: Answer all the questions, symbols have their usual meaning. Assume suitable data if missing. Clearly write all the assumptions before starting the solution.

Q.No. Questions CO M.M

1(a) The gate shown in fig.1 is 1.5 m wide and pivoted at O; a=1.0 m², D=1.20 m, and H=1.40 m. Determine (a) the magnitude and moment of the vertical component of the force about O, and (b) the horizontal force that must be applied at point A to hold the gate in position.

![Gate Diagram]

1(b) Derive the expression for Newton's Law of viscosity. A viscometer is built from a conical pointed shaft that turns in a conical bearing, as shown in fig.2. The gap between shaft and bearing is filled with a sample of the test oil. Obtain an algebraic expression for the viscosity \( \mu \) of the oil as a function of viscometer geometry (H, a, and \( \theta \)), turning speed \( \omega \), and applied torque \( \Gamma \).

![Viscometer Diagram]

contd...
2(a) Consider the vector flow field \( \mathbf{V} = ax + by \), where \( a = 1/4 \) \( \text{m/s}^2 \) and \( b = 1/3 \) \( \text{m/s} \). Coordinates are measured in meters. For a particle that passes through the point \((x, y) = (1, 2)\) at the instant \( t = 0 \), find expression for the pathline during the time interval from \( t = 0 \) to \( 2 \) s. Compare the expression for the pathline with the streakline through the same point at the instant \( t = 2 \) s.

2(b) Find the resultant velocity vector induced at point A in fig.3 due to the combination of uniform stream, vortex, and line source.

\[ K = 25 \, \text{m}^2/\text{s} \]
\[ U = 8 \, \text{m/s} \]
\[ m = 15 \, \text{m}^2/\text{s} \]

OR

2'(a) The velocity profile for a fully developed flow in a circular tube is given by \( V_x = V_{max}[1-(r/R)^2] \). Evaluate the rates of linear and angular deformation for this flow. Obtain an expression for the vorticity vector.

2'(b) Find the resultant velocity vector induced at point A in fig.4 by the uniform stream, line source, line sink, and vortex.

\[ m = 12 \, \text{m}^2/\text{s} \]

3(a) Consider the incompressible steady flow through a propeller as sketched in figure 5. Upstream of the propeller, the fluid is accelerated from speed \( V_1 \) to a higher speed \( V_p \) as it passes through the propeller. The acceleration is caused by a drop in pressure from atmospheric level at section 1 to \( P_m \) in front of the propeller. As the fluid flows through the propeller, the propeller raises the pressure of the fluid to a value \( P_{out} \), that is higher than atmospheric pressure. Therefore, in the region downstream of the propeller, the fluid further accelerates to a speed \( V_2 \) as the pressure falls to atmospheric value at station 2. As the flow accelerates, the streamlines passing through the tip of the propeller converge. The area of flow through the propeller is \( A_p \).

1. Select a narrow Control Volume (see fig. 5) surrounding the propeller alone and apply momentum equation to find the magnitude and direction of the force ‘\( F \)’ exerted by the fluid on the propeller.
2. Using Bernoulli’s theorem on the upstream and the downstream side separately, express the force ‘\( F \)’ obtained in (a) in terms of speeds \( V_1 \) and \( V_2 \).
3. Choosing an outer control volume bounded by the streamlines, apply the momentum equation and obtain an expression for speed \( V_p \) in terms of speeds \( V_1 \) and \( V_2 \).
3(b) Water enters the bottom of the cone in the fig. 6 at a uniformly increasing average velocity \( V = Kt \). If \( d \) is very small, derive an analytic formula for the water surface rise \( h(t) \), assuming \( h = 0 \) at \( t = 0 \).

4(a) Oil, with \( \rho = 890 \text{ kg/m}^3 \) and \( \mu = 0.07 \text{ kg/m·s} \), flows through a horizontal pipe 15 m long. The power delivered to the flow is 1 hp. (a) What is the appropriate pipe diameter if the flow is at the laminar transition point? For this condition, what are (b) \( Q \) in m\(^3\)/h; and (c) shear stress, \( \tau_w \) in kPa?

4(b) A tank contains 1 m\(^3\) of water at 20°C and has a drawn-capillary outlet tube at the bottom, as in fig. 7. Find the outlet volume flux \( Q \) in m\(^3\)/h at this instant. For water at 20°C, take \( \rho = 998 \text{ kg/m}^3 \) and \( \mu = 0.001 \text{ kg/m·s} \). For drawn tubing, take \( \varepsilon \approx 0.0015 \text{ mm} \).

4(c) Theoretically calculate the loss coefficient \( K_L \) for a sudden expansion case.

OR

4'(a) What is the use of constriction meter? On what basic principle these meters operate and what are the assumptions involved. Draw the neat sketch of venturi meter and develop the relation for the theoretical flow rate. Why the diverging section is longer than the converging part?

4'(b) Describe the following terms briefly:
   1. Coefficient of discharge
   2. Minor losses
   3. Entrance length
2018-19
B.TECH. (AUTUMN SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
Manufacturing Technology-I

Maximum Marks: 60 Credits: 04 Duration: Two Hours

1(a) Describe a master patterns. CO1 [2]

1(b) Design a master pattern for a 500 mm x 200 mm x 40 mm brass casting cuboid. Pattern material to be employed is an aluminium alloy having coefficient of liquid linear expansion of 2.5 % and solid linear expansion of 1.5 %. The coefficient of liquid linear expansion of brass is 3.5 % and solid linear expansion is 2.0 %. Give neat sketches of the product and the master pattern. CO1 [4]

1(c) Discuss cold chamber die casting process. CO1 [3]

1(d) Discuss manufacturing of cast iron pipes having inner and outer diameter as 100 mm and 110 mm through metal casting process. CO1 [6]

2(a) What is 'Joining process'? With the help of a block diagram classify various types of joining processes. Also list some of the advantages of joining process. CO2 [4]

2(b) What is adhesive bonding? List the factors affecting the mechanical properties of an adhesive joint. Why surface preparation is important in adhesive bonding? CO2 [3]

2(c) In a resistance welding of a lap joint of two steel sheets of 2.0 mm thick, a current of 5,000 A is passed for a period of 0.3 seconds. The effective resistance of the joint is 75 micro ohms. Density of steel is 8000 kg/m³ and latent heat of fusion of steel is 1400 kJ/kg. The resultant weld nugget formed is 5 mm in diameter and 2.5 mm thick. Calculate the percentage of heat distributed to the surroundings. CO2 [8]

OR

2'(a) What is a 'Cold Welding Process'? Explain the principles of operation of open joint pressure gas welding and closed joint pressure gas welding. CO2 [3]

2'(b) Explain the working principle of Submerged Arc Welding (SAW). Why SAW is treated as most productive welding among different liquid phase welding processes? CO2 [5]

2'(c) A shielded metal arc welding operation takes place on a cast iron work-piece with a 200 volt power supply. If a weld with a triangular cross section with a

CONT'D...
7.5 mm leg length is to be produced, estimate the current needed for a welding speed of 5 mm/s. Use an efficiency of 70% and specific energy for C1 electrode as 7.8 J/mm³.

3(a) With the help of a neat sketch define the angle of bite in rolling a strip of rectangular cross-section.

3(b) Derive an equation to show that for rolling a mild steel strip without applying any axial load, the coefficient of friction between the roll surface and the mild steel strip should be ≥ angle of bite.

3(c) Define reduction per pass in drawing.

3(d) Develop an equation to show the maximum reduction per pass for a cylindrical object.

3(e) Calculate the minimum number of passes required to an aluminium wire of 3.0 mm diameter from a stock of an aluminium rod of 10 mm diameter.

OR

3'(a) Derive an expression to calculate the stress to forge a long rectangular brass strip.

3'(b) Calculate the force required to forge a brass strip of 500mm x 30 mm x 20mm to 500 mm x 40 mm x 15 mm. Flow stress for brass can be calculated from the equation \( \sigma = K \varepsilon^n \). And the value of \( K \) and \( n \) can be assumed as 900 MPa and 0.5 respectively.

3'(c) With the help of a neat sketch discuss the working of a compound die.

4'(a) With the help of neat diagrams, explain the manufacturing of 'glass sheets and glass tubes'. Also give some examples of glass products made by blowing, pressing and sagging processes.

4'(b) Explain any TWO of the following:
   i. Pressure and Drape Thermoforming processes.
   ii. Rapid Prototyping and its advantages
   iii. Slip casting and its uses
   iv. Stretch blow moulding process.