2016-2017
B.TECH. AUTUMN (III- SEMESTER) EXAMINATION
(MECHANICAL ENGINEERING)
HIGHER MATHEMATICS
AM-231
Credits-04

Maximum Marks: 60
Duration: Two Hours

Answer all questions:

Q.1  (a) Evaluate the following:
      (i)  \( L \left\{ \frac{1-\cos t}{t^2} \right\} \) [8]
      (ii) \( L^{-1} \left\{ \frac{s}{s^4+4n^4} \right\} \)

(b) Using Laplace transformation solve the following initial value problem;
    \( y'' + 2y' + 5y = e^{-t} \sin t \), \( y(0)=0 \), \( y'(0) = 1 \).

OR

(b') An alternating voltage \( E \sin \omega t \) is applied at \( t = 0 \) to a circuit of inductance \( L \) and resistance \( R \). If the initial current be zero, show that the current at time \( t \) is
\[
E \left( e^{-Rt/L} \sin \gamma + \sin(\omega t - \gamma) \right) / \sqrt{R^2 + L^2 \omega^2}, \text{ where } \tan \gamma = L \omega / R.
\]

Q.2  (a) Find the directional derivative of \( \phi = (x^2 + y^2 + z^2)^{-\frac{1}{2}} \) at the point (3,1,2) in the direction of the vector \( y\hat{i} + zx\hat{j} + xy\hat{k} \).

OR

(a') Show that \( \text{grad } f(r) \times \hat{r} = 0 \).

(b) Show that the vector field \( \vec{F} = (2xy + z^2)\hat{i} + (2yz + x^2)\hat{j} + (2xz + y^2)\hat{k} \) is irrotational. Find the scalar function \( \phi \) such that \( \vec{F} = \text{grad } \phi \).

Q.3  (a) Show that \( \int_C \vec{F} \cdot d\vec{r} = \frac{1}{2} k(a^2 + b^2) \) where
\[
\vec{F} = k[3a \sin^2 \theta \cos \theta \hat{a} + a(2 \sin \theta - 3 \sin^3 \theta) \hat{b} + b \sin 2\theta \hat{c}]
\]
and \( C \) is the curve \( \vec{r} = a \cos \theta \hat{a} + a \sin \theta \hat{b} + b \theta \hat{c} \) from \( \theta = \frac{\pi}{4} \) to \( \theta = \frac{\pi}{2} \).

(b) Verify divergence theorem for \( \vec{F} = 4x\hat{i} - 2y^2\hat{j} + z^2\hat{k} \), taken over the region bounded by the cylinder \( x^2 + y^2 = 4, z = 0, z = 3 \).

OR

(b') Verify Green's theorem for \( \int_C (x^2 - \cosh y)dx + (y + \sin x)dy \), where \( C \) is the rectangle with vertices \((0,0), (\pi, 0), (\pi, 1), (0, 1) \) and \((0,1)\).
Q.4 (a) Determine the analytic function $f(z) = u + iv$ if

$$u + v = \frac{\sin 2x}{\cosh 2y - \cos 2x}.$$ 

(b) If $f(a) = \int_c^{\frac{3z^2 + 7z + 1}{z - a}} dz$ where $c$ is $|z| = 2$,

find $f(3), f'(1 - i), f''(1 - i)$.

OR

(b') Evaluate, using Cauchy's integral formula $\int_c^{\frac{z+4}{z^2 + 2z + 5}} dz$ where $c$ is

(i) $|z + 1 + i| = 2$  (ii) $|z + 1 - i| = 2$. 
2016-17
B.TECH. (AUTUMN SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
Mechanics of Solids (ME213)

Maximum Marks: 60 Credits: 04 Duration: Two Hours

Answer all 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. (a)</td>
<td>Write 3D stress equilibrium equations in rectangular coordinates.</td>
<td>(1.5)</td>
</tr>
<tr>
<td>(b)</td>
<td>Define stress invariants.</td>
<td>(1.5)</td>
</tr>
<tr>
<td>(c)</td>
<td>Draw Mohr’s circle for pure stress case.</td>
<td>(1)</td>
</tr>
</tbody>
</table>
| (d)   | A rectangular steel bar having a cross section 2 cm × 3 cm is subjected to a tensile force of 6000 N. If the axes are chosen as shown in Figure 1, determine the normal and shear stresses on a plane whose normal has the 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) \( n_x = n_y = n_z = \frac{1}{\sqrt{3}} \)

![Figure 1](attachment:image.png)

**Figure 1**

OR

1'. (a) For the plain strain case, write strain displacement relations

(i) Rectangular coordinate system
(ii) Cylindrical coordinate system.

(b) In a solid body, the displacements in micro units along \( x \), \( y \) and \( z \) directions are given by

\[
\mathbf{u} = (x^2 + y)\mathbf{i} + (3 + z)\mathbf{j} + (x^2 + 2y)\mathbf{k}
\]

Determine principal strains at (3, 1, -2).

\[\text{Contd...}2\]
2. What are compatibility equations? Derive the compatibility relations for the plain strain case. Check the compatibility of the following strain field:

\[ \epsilon_{xx} = 3x^2y, \quad \epsilon_{yy} = 4y^2x + 0.01, \quad \gamma_{xy} = 2xy + 2x^3 \]

3. (a) What do you understand by longitudinal and hoop stress and state their significance? Explain by means of neat sketches.

(b) A cast iron pipe of 750 mm diameter is used to carry water under a head of 60 m. Determine the following
   a) Thickness of the pipe if the permissible stress is to be 20 MPa.
   b) Corresponding hoop stress and circumferential strain.
   c) Change in diameter when the head changes to 100 m.
   (Take specific weight of water = 9.81 kN/m^3)

OR

3'.(a) Explain briefly Lame's Theory for Thick Cylinder.

(b) A thick cylinder of 200 mm outside diameter and 140 mm inside diameter, is subjected to internal pressure of 40 MPa and external pressure of 24 MPa. Determine the maximum shear stress in the material of the cylinder at the inside diameter.

4. A continuous beam \( ABC \) as shown in Figure 2, supports a uniform load \( q \) determine the reactions and plot the elastic curve, and bending moment diagram.

5. (a) State and explain any two of the following:
   (i) Compound cylinders.
   (ii) Macaulay's Method.
   (iii) Moment area method for slope and deflection of beams.
   (iv) Euler's Theory related to buckling.

5. (b) Using Castigliano's Theorem, determine the vertical deflections of point \( P \) of steel beam of uniform flexural rigidity \( EI \), as shown in Figure 3.
Answer all the questions. Assume suitable data if missing.

1. (a) Discuss the defects in casting due to low mould hardness. Also discuss the defects if mould hardness is high. 4
1. (b) Dimension of a mould cavity is $500 \text{ mm} \times 350 \text{ mm} \times 350 \text{ mm}$. The volumetric solid shrinkage and volumetric liquid shrinkage of the metal to be poured are 7% and 9% respectively. Design a side open riser. Compute the velocity of the molten metal at the bottom of the down sprue. 8

2. (a) With the help of neat sketches discuss the effect of using lubricant in open die forging processes. 4

OR

2. (a') Discuss the densities of the products obtained through metal forming as compare to similar products obtained through metal casting. 4

2. (b) Calculate minimum possible reduction per pass while drawing a wire from a metal stock. And calculate the number of passes required to a wire of 10 mm from a stock of 50 mm. 8

OR

2. (b') The height of 7070-O aluminium alloy rectangular block (length = 100 mm, height = 40 mm and width = 25 mm) is reduced to 80%. Using the expression for average pressure estimate the forging force. The yield stress of the metal is 150 MPa and the coefficient of friction is 0.2. 8

3. (i) Discuss the joining of two mild steel rods of 50 mm diameter by employing friction welding technique. 4

3. (ii) A pipe of 65-35 brass with outer and inner diameter of 50 mm and 40 mm is to be welded on to a flat brass plate 70 mm x 70 mm x 10 mm through flush welding (FW) technique. The axis of the pipe is to be kept perpendicular to the face of the plate. To get better strength, metal up to 1 mm thick is to be flushed out from each component. If a current of 50 ampere at 10 V is passed through the components, compute the time required to flow the current. Assume energy required is $5.7 \text{ J/mm}^3$ and the efficiency is 55%. 8

OR

Contd...
3. (ii) An oxyacetylene gas welding (OAW) is to be taken on carbon steel to produce a fillet/butt weld. The welding speed is 25 mm/s. Compute the amount of acetylene gas required if the weld width is 7 mm. The efficiency of welding is 65%. Take the relative density of metal as 7.8.

4. (a) Differentiate between:
   (i) Impregnation and infiltration
   (ii) Compacting and hot pressing
   (iii) Pre-sintering and sintering

4. (b) What are self-lubricating bearings? Explain their process of manufacturing.

5. (a) Explain the function of dielectric fluid in EDM. Name common dielectric fluids used in EDM.
   (b) What is overcut in EDM
   (c) What are the differences between ECG and conventional grinding?
   (d) What are the materials commonly used for making a tool in ECM?

OR

5' (a') Write a detailed note on ceramics, their classification, properties and application
   (b') Explain with the help of sketch the process of Injection moulding.
### Autumn 2016-17
B.TECH. (WINTER SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
EXPERIMENTAL METHODS AND ANALYSIS
ME220

**Answer all the questions.**

**Assume suitable data if missing.**

**Statistical Tables are allowed.**

**Notations used have their usual meaning.**

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
</table>
| 1.    | (a) Let X and Y denote the lengths of life, in years, of two components in an electronic system. If the joint density function of these variables is  
\[ f(x, y) = \begin{cases} 
    e^{-(x+y)}, & x > 0, y > 0 \\
    0 & elsewhere 
\end{cases} \]  
Find \( P(0 < X < 1 / Y = 2) \)  
(b) In a testing a certain kind of touch screen of mobile breaks 25% of the time it falls down from hand. Of the next 15 touch screens tested, find the probability that (i) from 3 to 6 have broken, & (ii) less than 5 have broken. | 2 x 5 |
| 1'    | (a) If a dealer's profit, in units of $5000, on a new automobile can be looked upon as a random variable \( X \) having the density function  
\[ f(x) = \begin{cases} 
    2(1-x), & 0 < x < 1 \\
    0 & elsewhere 
\end{cases} \]  
Find the average profit per automobile.  
(b) A certain type of storage battery lasts on average 5 years with standard deviation of 0.5 years. Assuming the battery life is normally distributed, find the probability that a given battery will last between 4.3 & 5.7 years. Show the probability on normal distribution diagram also. | 2 x 5 |
| 2.    | Answer any two of the following:  
(a) The average life of a coffee making machine is 7 years with a standard deviation of 1 year. Assuming that the lives of these machines follow approximately a normal distribution, find the value of \( 'x' \) to the right of which 25% of the mean computed from random samples of size 9 would fall. | 2 x 5 |

Contd... 2.
(b) The contents of seven similar containers of sulfuric acid are 9.8, 10.2, 10.4, 9.8, 10.0, 10.2 and 9.6 liters. Find a 95% confidence interval for the mean contents of all such containers, assuming an approximately normal distribution.

(c) A soft drink dispensing machine is said to be out of control if the variance of the contents exceeds 1.15 deciliters. If a random sample of 25 drinks from this machine has a variance of 2.03 deciliters, does this indicate at the 0.05 level of significance that the machine is out of control? Also draw a chi-square distribution. Assume that the contents are approximately normally distributed.

3. Compute & interpret the correlation coefficient 'r' for the following performance of 5 students in M.Tech. admission test and in GATE.

<table>
<thead>
<tr>
<th>GATE score</th>
<th>700</th>
<th>400</th>
<th>550</th>
<th>300</th>
<th>450</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.Tech. Admission test</td>
<td>95</td>
<td>80</td>
<td>82</td>
<td>65</td>
<td>75</td>
</tr>
</tbody>
</table>

4 (a) Give one example each of the following types of instruments with very precise explanation:
(i) Passive type instrument.
(ii) Proximity type instrument.

(b) A temperature measuring device with a time constant of 0.15 s has a voltage output. The device is used to measure an input signal of the form $T(t) = 115 + 12 \sin 2t$ °C. Determine the predicted output signal with time assuming first order behaviour and a static sensitivity of 5 mV/°C.

4 (c) Fill in the blanks:
(i) Maximum amount of power may be drawn from the device when the internal impedance of the device ______ impedance of external load.
(ii) Bias in an instrument is defined as ________.
(iii) For a unit ramp input applied to a first order system, with time constant $\tau$, the steady state error is ________

OR

4' (a) Define hysteresis. A liquid level sensor has an input range of 0 to 15 cm. Use the calibration results given in the table to estimate the maximum hysteresis as a percentage of f.s.d.

<table>
<thead>
<tr>
<th>Level $h$ cm</th>
<th>0.0</th>
<th>1.5</th>
<th>3.0</th>
<th>4.5</th>
<th>6.0</th>
<th>7.5</th>
<th>9.0</th>
<th>10.5</th>
<th>12.0</th>
<th>13.5</th>
<th>15.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output volts $h$ increasing</td>
<td>0.00</td>
<td>0.35</td>
<td>1.42</td>
<td>2.40</td>
<td>3.43</td>
<td>4.35</td>
<td>5.61</td>
<td>6.50</td>
<td>7.77</td>
<td>8.85</td>
<td>10.2</td>
</tr>
<tr>
<td>Output volts $h$ decreasing</td>
<td>0.14</td>
<td>1.25</td>
<td>2.32</td>
<td>3.55</td>
<td>4.43</td>
<td>5.70</td>
<td>6.78</td>
<td>7.80</td>
<td>8.87</td>
<td>9.65</td>
<td>10.2</td>
</tr>
</tbody>
</table>

(b) What are the two advantages of analogue instruments over digital ones?
(c) An elastic force sensor has an effective seismic mass of 0.1 kg, a spring stiffness of 10 N/m and a damping constant of 14 N-s/m. Calculate
(i) Sensor natural frequency
(ii) Sensor damping ratio
(iii) Transfer function relating displacement and force

5. (a) A heat-exchanger facility is designed to use type J thermocouples to sense an outlet gas temperature. A safety device is installed to shut down the flow heating system when the gas temperature reaches 800°C. During a periodic maintenance inspection, the thermocouple is judged to need replacement because of oxidation. By mistake, a type K thermocouple is installed as the replacement. What may be the results of such an installation?

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Type J (emf in mV)</th>
<th>Type K (emf in mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>45.494</td>
<td>33.275</td>
</tr>
<tr>
<td>1000</td>
<td>57.953</td>
<td>41.276</td>
</tr>
<tr>
<td>1200</td>
<td>69.553</td>
<td>48.838</td>
</tr>
</tbody>
</table>

(b) Explain the working of Counter Analog to Digital Convertor with the help of a diagram.

OR

5. (a) What is the property of LEDs? Name commonly used LED materials for emitting red and green lights.

(b) Derive a relation for Gauge factor. Why do semiconductor strain gauges have large values of Gauge factor?

(c) What is the function of a discharge lamp and fuser in a Laser Jet Printer?

6. (a) Explain the working of Knudsen Gage with the help of a diagram.

(b) What does a dynamometer measure? Name three types of dynamometers.

(c) What are RTDs?

(d) Why is a tapered glass tube used in rotameters?
Maximum Marks: 60

Answer the following questions

Use the thermodynamic tables/chart attached with the question paper.

Missing data, if any, may be assumed suitably.

1(a) Using the equation of state \( P(v - a) = RT \), verify the cyclic relation among \( P, V \) and \( T \).

1(b) A 3.27 m\(^3\) tank contains 100 kg of nitrogen at 175 K. Determine the pressure in the tank, using the van der Waals gas equation. Compare your results with the actual value of 1505 kPa.

\[
R_u = 8.314 \text{ kJ/kgmol K}, \quad M = 28.013 \text{ kg/kmol}, \quad T_c = 126.2 \text{ K}, \quad P_c = 3.39 \text{ MPa}
\]

OR

1′(a) Using \( h = f(T, P) \) and \( s = f(T, P) \) prove the following:

\[
dh = C_p \, dT + \left[ v - T \left( \frac{\partial v}{\partial T} \right)_p \right] dP
\]

1′(b) Prove that the Joule-Thomson coefficient for an ideal gas is zero.

2(a) With the help of a diagram explain the process of evaporative cooling. Also show the process on Psychrometric chart.

2(b) A stream of warm air with a dry-bulb temperature of 40\(^\circ\)C and a wet-bulb temperature of 32\(^\circ\)C is mixed adiabatically with a stream of saturated cool air at 18\(^\circ\)C. The mass flow rates of the warm and cool airstreams are 8 and 6 kg/s, respectively. Assuming a total pressure of 1 atm, determine for the mixture (i) the specific humidity and (ii) the relative humidity. (Use the enclosed Psychrometric chart).

3(a) Write various desirable properties of refrigerants.

3(b) With the help of schematic diagram describe the working of vapor absorption refrigeration system.

OR

3′ A vapour compression refrigeration system with evaporator and condenser pressures 2.437 bar and 7.675 bar, respectively, uses R134a as refrigerant. Calculate the Carnot COP and the COP of the cycle for the following cases:

(i) dry saturated vapour delivered to the compressor where it is compressed isentropically, and no under cooling of the condensed liquid

(ii) dry saturated vapour delivered to the condenser after isentropic compression and no under cooling of the condensed liquid.
4(a) Define compression ratio, cut-off ratio and mean effective pressure for Diesel engine.

4(b) A gas turbine unit has a pressure ratio of 10:1 and a maximum cycle temperature of 700 °C. The isentropic efficiencies of the compressor and turbine are 0.82 and 0.85, respectively. Calculate the turbine work and compressor work when the air enters the compressor at 15 °C. Take $C_p$ = 1.005 kJ/kg K and $n = 1.4$ for the compression process and $C_p$ = 1.11 kJ/kg K and $n$ = 1.333 for the expansion process.

OR

4(b') An air-standard diesel cycle has a compression ratio of 20:1 and the heat transfer to the working fluid per cycle is 1800 kJ/kg. At the beginning of the compression process, the pressure is 0.1 MPa and the temperature is 15 °C. Determine the pressure and temperature at the end of each process and thermal efficiency of cycle. For air $C_p$=1.005 kJ/kg K. Show the cycle on T-s coordinates.

5(a) With the help of P-v and T-s diagrams explain the isothermal, isentropic and polytropic compression processes. Which one has the least compression work?

OR

5(a') Explain the working of a centrifugal compressor.

5(b) A two stage reciprocating compressor with ideal intercooling is following polytropic law for compression and expansion processes. If $P_d$ is the discharge pressure of the H.P. compressor and $P_s$ is the suction pressure of the L.P. compressor, prove that the expression for minimum compression work per kg of gas is given by

$$w_c = \frac{2n}{n-1} RT_1 \left( \frac{P_d}{P_s} \right)^{\frac{n-1}{2n}} - 1$$

........ End of Question Paper ........

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**Table: Properties of Refrigerant R134a**

<table>
<thead>
<tr>
<th>$t_a$ (°C)</th>
<th>$P_s$ (bar)</th>
<th>$\gamma$ (m/kg)</th>
<th>h_r (kJ/kg)</th>
<th>h_s (kJ/kg)</th>
<th>$s_r$ (kJ/kg K)</th>
<th>$s_s$ (kJ/kg K)</th>
<th>$h$ (kJ/kg)</th>
<th>$s$ (kJ/kg K)</th>
<th>$h$ (kJ/kg)</th>
<th>$s$ (kJ/kg K)</th>
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<tbody>
<tr>
<td>-15</td>
<td>1.638</td>
<td>0.118</td>
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<td>0.9272</td>
<td>1.7228</td>
<td>295.81</td>
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<td>0.031</td>
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<td>1.7051</td>
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<td>1.7448</td>
<td>332.25</td>
<td>1.7804</td>
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2016-2017
B. TECH. III Semester Examination
(Mechanical)
Fluid Mechanics -I
(ME231)

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

NOTE: Answer all the questions, symbols have their usual meaning.
Assume suitable data if missing
Moody's diagram and sheets of mathematical identities is permitted.
Clearly write all the assumptions before starting the solution.

1. A circular aluminum shaft mounted in a journal is shown (fig.1). The symmetric clearance gap between the shaft and journal is filled with SAE 10W-30 oil at T=30°C. The shaft is caused to turn by the attached mass and cord. Develop and solve a differential equation for the angular speed of the shaft as a function of time. Calculate the maximum angular speed of the shaft. \( \mu = 0.095 \text{ kg m}^{-1}\text{s}^{-1} \)

\[ R = 25 \text{ mm} \]
\[ L = 50 \text{ mm} \]
\[ 1.5L \]
\[ \text{Clearance, } a = 0.5 \text{ mm} \]
\[ M = 10 \text{ g} \]

Fig 1

2a. A flow field is given by \( \vec{V} = ax\hat{i} - by\hat{j} \), where \( a=b=1\text{s}^{-1} \). Verify that the parametric equations for particle motion are given by \( x_p = C_1 e^{at} \) and \( y_p = C_2 e^{-bt} \). Obtain the equation for the pathline of the particle located at the point \((x, y) = (1, 2)\) at the instant \(t=0\). Compare this pathline with the streamline through the same point.

2b. Describe the following terms briefly:
1. Lagrangian flow description
2. Vorticity
3. Circulation
3. Flow past a Rankine body is formed from the superposition of a uniform flow \( U=20 \text{ m/s} \) in the \(+x\) direction, and a source and a sink of equal strength \( k=3\pi \text{ m}^2/\text{s} \) located on the \( x\)-axis at \( x=-a \) and \( x=a \), respectively. Find the half width of the body. Also find the velocity and pressure at the points \((0, h)\), and draw the streamline pattern.

OR

3'. A source and sink of equal strength located on the \( x\)-axis at \( x=-a \) and \( x=a \), respectively. For any point 'p' in the flow domain find the superimposed \( \psi \) and \( \phi \) in Cartesian system of coordinates. Show that the pattern of streamline represented by \( \psi = \text{constant} \) is a circle. Find the radius of the circle.

4a. Water issues from conical tank (fig.1) whose radius of cross-section varies linearly with the height from 10 cm at the bottom of the tank. The slope of tank wall with the vertical is 30°. A short pipe of 2 cm diameter is fitted at the bottom for discharging the water. Calculate the time taken for the tank to be emptied from an initial water level of 70 cm. Assume that the pipe entry loss coefficient is 0.5, and is constant at all time.

![Fig 1](image)

4b. Discuss the limitations of Bernoulli’s equation.

OR

4'. Consider the incompressible steady flow through a propeller as sketched in figure 2. 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 \( P_a \) 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 \( A_F \).

a. Select a narrow Control Volume (see fig. 2) 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.

b. 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 \( V_2 \).
c. Choosing an outer control volume bounded by the streamlines (see fig. 2), apply the momentum equation and obtain an expression for speed \( V_p \) in terms of speeds \( V_1 \) and \( V_2 \).

d. Work done per second by propeller and theoretical efficiency.

![Diagram of fluid flow](image)

Fig 2

5. Obtain the velocity distribution of steady, incompressible, fully developed viscous flow between stationary parallel plates. Also derive the equation of flow rate per unit width in terms pressure difference. Draw the profile of velocity and pressure. What would be the expected profile if the upper plate is moving with constant velocity? Only draw the expected profile. (Take a rectangular element for derivation purpose and consider 'e' as function of 'y'.)