2015-16
B.TECH (WINTERSEMESTER) EXAMINATION
MECHANICAL ENGINEERING
NUMERICAL METHODS & OPTIMIZATION
AM331

Maximum Marks: 60

Note: (i) Answer all the questions
(ii) Programmable calculator is not allowed

Q.No. Question

1(a) Find by iteration method, the real root of the equation \( 3x - \cos x - 2 = 0 \),
correct to five decimal places. (Take \( x_0 = 0.5 \))

\[ OR \]

1(a') Using Newton-Raphson method, establish the formula
\[ x_{n+1} = \frac{1}{2} \left( x_n + \frac{N}{x_n} \right) \]
to calculate the square root of \( N \). Hence find the square root of 5 correct to four
places of decimal

1(b) Apply three iterations Gauss-Seidel iteration method to solve the equations
\[ 20x + y - 2z = 17; \quad 3x + 20y - z = -18; \quad 2x - 3y + 20z = 25. \]
with initial
approximation \( y_0 = z_0 = 0 \)

1(c) Determine \( p, q \) and \( r \) so that the order of the iterative method
\[ x_{n+1} = px_n + \frac{q}{x^2_n} + \frac{r}{x^3_n} \]
for \( \Delta \) becomes as high as possible.

2(a) Prove the following with the usual notation:
\[ hD = \log(1 + \Delta) = -\log(1 - \nu) = \sinh^{-1}(\mu \delta) \]

\[ OR \]

2(a') Obtain Newton's forward interpolation polynomial for the following data:
\[ x: 4 \quad 6 \quad 8 \quad 10 \]
\[ y: 1 \quad 3 \quad 8 \quad 16 \]

Use it to find the value of \( y \) for \( x = 5 \).

Contd....2.
2(b) By means of Newton’s divided difference formula, find the cubic polynomial in $x$ from the given data:

\[ y(0) = 2, \quad y(1) = 3, \quad y(2) = 12, \quad y(5) = 147 \]

2(c) Derive two point Gauss formula

\[ \int_{-1}^{1} f(x) \, dx = f\left(-\frac{1}{\sqrt{3}}\right) + f\left(\frac{1}{\sqrt{3}}\right) \]

Using this formula evaluate the integral $I = \int_{0}^{1} \frac{dx}{1+x^2}$. Compare with the exact solution.

3(a) Using Taylor’s series method, find $y(0.1)$ correct to six places of decimal, given that $y' = xy + 1, \quad y(0) = 1$

OR

3(a') Using Runge-Kutta method of order 4, obtain $y(1.1)$, given that $y(1) = 1.2$ and $y$ satisfies the equation $y' = 3x + y^2$.

3(b) Solve, by finite difference method, the boundary value problem:

\[ y'' = x + y, \quad y(0) = y(1) = 0 \]

Take $h = \frac{1}{4}$.

4(a) Solve the following linear programming problem graphically:

Max $z = 2x_1 + 3x_2$

Subject to constraints $x_1 + x_2 \leq 4, \quad 2x_1 + x_2 \geq 2, \quad x_1, x_2 \geq 0$

4(b) Solve, by Simplex method, the linear programming problem:

Max $z = 3x_1 + 2x_2$

Subject to constraints $x_1 + x_2 \leq 4, \quad x_1 - x_2 \leq 2, \quad x_1, x_2 \geq 0$

OR

4(b') Construct the Dual of the following linear programming problem

Min $z = 3x_1 + x_2$

Subject to constraints $x_1 + x_2 \geq 1, \quad 2x_1 + 3x_2 \geq 2, \quad x_1, x_2 \geq 0$ and then solve it.
For a reciprocating engine mechanism, make a complete inertia force analysis using the following data:

Length of the crank = 15 cm; Length of the connecting rod = 56 cm;

Crank angle with the line of stroke = 60°; Distance of C.G of crank from the main bearing = 10 cm; Distance of C.G of connecting rod from crank pin = 24 cm; Crank speed = 2000 rpm counter clock wise. Mass of crank = 5 kg; Mass of connecting rod = 8 kg; Mass of slider (piston) = 6 kg; Mass moment of inertia of crank =120 kg·cm²; Mass moment of inertia of connecting rod = 1000 kg·cm².

A vertical single cylinder gas engine running at 1800 rpm has a crank 60 mm long and the length of connecting rod is 240 mm. The diameter of the piston is 80 mm and the mass of the reciprocating parts is 1.2 kg. At a point during the power stroke when the crank has travelled 20 mm from the top dead centre position, the pressure on the piston is 800 KN/m². Determine

i) The net force on the piston

ii) The thrust in the connecting rod

iii) The thrust on the sides of the cylinder walls

iv) The engine speed at which the above values are zero.

The torque delivered by a two-stroke engine is represented by

\[ T = [1000 + 300 \sin \theta - 500 \cos \theta] \text{ N.m} \]

where \( \theta \) is the angle turned by the crank from the inner-dead centre. The engine speed is 500 rpm. The mass of the flywheel is 500 kg and radius of gyration 400 mm.
Determine
i) The power developed.
ii) The total percentage fluctuation of speed.
iii) The angular acceleration of the flywheel when the crank has rotated through an angle of 60° from the inner dead centre.
iv) The maximum angular acceleration and retardation of the flywheel.

OR

2 (b') Derive an expression for the acceleration of piston and angular acceleration of connecting rod of a reciprocating engine. Further, discuss in brief the significance of turning moment diagram and the function of flywheel.

3 (a) Explain in brief the following:
   i) Significance of balancing for rotors of high speed engines.
   ii) Static and Dynamic Balancing Procedure
   iii) Primary and secondary unbalance in reciprocating engines
   iv) Hammer Blow and Tractive Force

3 (b) A single cylinder reciprocating engine has a reciprocating mass of 60 kg. The crank rotates at 60 rpm and the stroke is 320 mm. Mass of the revolving parts at 160 mm radius is 40 kg. If two-third of the reciprocating parts and whole of the revolving parts are to be balanced, determine
   i) The balance mass required at a radius of 350 mm.
   ii) The unbalance force when the crank has turned 50° from the top-dead centre.

OR

3(b') A shaft supported in bearings 2 m apart projects 0.5 m beyond bearings at each end. It carries three pulleys one at each end and one at the centre of its length. The masses of the end pulleys are 50 kg and 26 kg and their centre of mass are 15 mm and 20 mm respectively from the shaft axes. The mass of the centre pulley is 46 kg and its centre of mass is 16 mm from the shaft axis. The pulleys are arranged in a manner that they give static balance. Determine
   i) The relative angular positions of the pulleys.
   ii) The dynamic forces developed on the bearings when the shaft rotates at 240 rpm.

Contd.....3.
4 (a) Draw the profile of a cam operating a roller follower from the following data:
   i) The cam lifts the follower by 30 mm during its 120° rotation with S.H.M.
   ii) The follower remains at rest for next 30° rotation of the cam
   iii) The follower then descends to its original position during 150° rotation of
        the cam with S.H.M.
   iv) The follower remains at rest for the remaining period of cam rotation

The minimum radius of cam is 25 mm and the roller diameter is 15 mm. If the
cam rotates at a uniform speed of 150 rpm, find the maximum velocity and
acceleration of the follower during ascent and descent.

4 (b) Explain the gyroscopic effect on a four-wheeled vehicle and derive the
      condition of stability of the vehicle while taking a turn.

OR

4 (b') What is a gyroscopic couple? Explain the gyroscopic effect on the naval ships
      with suitable diagrams, during
      i) Yawing
      ii) Pitching and
      iii) Rolling

5 (a) What is the controlling force of a governor? How are the controlling force curves
      drawn? How do they indicate the stability or instability of a governor? Indicate
      the shape of such a curve for an isochronous governor.

5 (b) In what ways a centrifugal governor is different from a spring controlled
      governor?
      Derive the expression for stiffness of the spring of a Hartnell governor in terms of
      the centrifugal force and geometric parameters of the governor.

OR

5 (b') A Proell governor has all four arms of length 300 mm. The upper arms are
      pivoted on the axis of rotation whereas the lower arms are attached to the sleeve
      at a distance of 40 mm from the axis of rotation. The mass of each ball is 3.75 kg
      and the mass on the sleeve is 40 kg. The balls are attached to the 100 mm long
      extension of the lower arms which are parallel to the governor axis at minimum
      radius of rotation. The minimum and maximum radii of rotation are 180 mm and
      240 mm respectively. Find the corresponding equilibrium speed.
2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
MECHANICAL
ENERGY CONVERSION SYSTEMS
ME 322

Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

Q.No.  M.M.
1(a) A liquid blend of 80% n-heptane (C₇H₁₆) and 20% ethanol (C₂H₆O) is burned with [06]
300% excess air at 0.1 MPa and 25°C in a steady flow process. Determine the adiabatic
flame temperature, A/F ratio on mass and mole basis.

1(b) 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.

OR

1'(a) Define equilibrium constant \( K_p \), express it in terms of standard state Gibbs function [03]
Change \( \Delta G^\circ \), partial pressures, number of moles and molar concentration.

1'(b) Liquid propane (C₃H₈) at 25°C, 1.2 kg/min enters a combustion chamber, where
it is mixed and burned with 150% excess air which enters the chamber at 12°C.
The combustion gases consisting of CO₂, CO, H₂O, O₂ and N₂ leave at 1200 K, 2 atm. Determine
the equilibrium constant \( K_p \) and express it in terms of number of moles
and pressure P. If the equilibrium composition of the gaseous combustion products is:
3CO₂ + 7.5O₂ + 4H₂O + 47N₂, determine the heat transfer rate from the chamber. The
equilibrium equation between CO₂, CO and O₂ can be expressed as: CO₂ ⇌ CO + \( \frac{1}{2} \) O₂

Contd.....2.
O₂. Assume H₂O as inert gas. The amount of NO form will be negligible and is neglected.

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 then goes to the high pressure turbine. A fraction of steam is then bled off from the high pressure turbine at 100 bar with 0.9 dryness fraction and supplied to the reheater where it is reheated to 500°C at the same pressure and then taken to a low pressure turbine where the steam is expanded to the condenser pressure of 15 kPa. The condensed steam then 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. Atmospheric air enters the air preheater at 300K and enters the boiler furnace at 360K. Show the arrangement/plant layout of the components, labelling the state points and calculate the heat transferred in the economizer, boiler, superheater, reheater and air preheater. Take $c_{p_{air}} = 1.004$ kJ/kg K.

OR

2' An ideal regenerative Rankine cycle may be thought of, where the feedwater after being compressed isentropically in the pump is circulated around the turbine casing in counter flow to the direction of flow of steam in the turbine, exchanging heat with the expanding steam, so that the liquid water is heated while the steam temperature drops. Draw the plant layout and the corresponding T-s plot and derive an expression for its thermal efficiency, showing that it is equal to that of Carnot cycle for the same temperature limits.

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

4 At a particular stage of a reaction turbine the mean blade speed is 150 m/s. The exit angles of the fixed and moving blades are 20°. The inlet angles of the fixed and moving blades are 30°. The stage efficiency is 80 %. The pressure at entry to the stage is 15 bar

Contd....3.
and the temperature is 200°C. Determine: (i) the specific enthalpy drop across the stage in kJ/kg, (ii) the drum diameter and blade height if the blade height is one-tenth of the drum diameter and the steam flow is 100kg/s, (iii) the percentage increase in relative velocity across the blading as the result of the pressure drop across the blading.

5(a) Write down the energy balance for a mixing and non mixing type of condenser.

5(b) In an induced type of mechanical cooling tower, water from the condenser enters the tower at 44°C and 5.5 litres/s. The induced draft fan inducts 9m³/s of outside air at 18°C and 60% RH and air leaving the tower is assumed saturated at 26°C. If the power consumed is 4.75 kW, calculate (i) the make up water rate in kg/s, (ii) the enthalpy of the cooled water leaving the cooling tower and its temperature.
Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

Q.No.  Question  M.M.

1(a)  Compare the thermal efficiencies of Otto, Diesel and Dual cycles for the following cases
(i) For the same compression ratio
(ii) For the same peak pressure and temperature
(iii) For the same compression ratio and same heat input
Inlet conditions are same for all the above cases. Give reasons of your conclusion.  [06]

1(b)  What do you understand by scavenging in 2-stroke engines? Define Delivery Ratio, Scavenging Efficiency, Trapping Efficiency and Charging Efficiency.  [06]

2(a)  Discuss the type of mixture requirements of a SI engine from no load to full load under steady state operation. Also discuss the mixture quality requirement for transient conditions.  [07]

2(b)  Determine the air-fuel ratio at 4570 m altitude in a carburettor adjusted at sea level for a 15.2:1 ratio. At sea level, air temperature is 20 °C and pressure 1.01325 bar.
The temperature of the air decreases with altitude given by the expression
\[ t = t_s - 0.0065 \, h \], where \( h \) = height in m and \( t_s \) = sea level temperature in °C. The air pressure decreases with altitude as per relation
\[ h = 19220 \ln \left( 1.013/p \right) \], where \( p \) is in bar. State any assumptions made.

OR

Contd.....2.
2'(a) Discuss the purpose of Supercharging in IC engines and with the help of neat sketches, describe various systems of Mechanical supercharging and Turbocharging.

2'(b) The entire output of a supercharged 4-stroke cycle oil engine is used to drive an air compressor. The air enters the compressor at 20 °C and is delivered to a cooler which removes heat at the rate of 1335 kJ/min. The air leaves the cooler at 62 °C and 1.72 bar. Part of this air flow is used to supercharge the engine which has a volumetric efficiency of 0.70 based on induction manifold conditions of 62 °C and 1.72 bar. The engine which has six cylinders of 90 mm bore and 100 mm stroke runs at 2000 rpm and delivers an output torque of 150 Nm. The mechanical efficiency of the engine is 0.75. Determine (i) the engine indicated mean effective pressure (ii) the air consumption in kg/min (iii) air flow into compressor in kg/min.

3(a) 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.

3(b) What do you understand by ‘Octane Number’ of a SI engine fuel. Discuss the test conditions and method of its determination. Also explain the term ‘Sensitivity’.

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

4(b) A closed cycle gas turbine uses helium as the working substance. The gas enters the compressor at 4 bar & 320 K and discharges at 16 bar & 590 K. It then enters a regenerator of effectiveness 70%. From the regenerator, it goes to another heat exchanger where further heat is added from combustion gases. The helium then enters the turbine at 15.5 bar & 1400 K and leaves the turbine at 4.2 bar & 860 K to enter to the regenerator. From the regenerator, it goes to the compressor through a cooler where heat is rejected before compression. Determine, (i) the compressor and turbine efficiencies (ii) the thermal efficiency of the cycle (iii) the heat rejected in the cooler before compression (iv) the helium flow rate for a net power output of 100 MW. Take $C_p$ and $\gamma$ for helium as 5.2 kJ/kg K and 1.67 respectively.

OR

4'(a) With the help of neat sketches, describe the working of Liquid propellant and Solid

Contd.....3.
propellant rocket engines. List some of the commonly used solid and liquid propellants.

4(b) In an ideal gas turbine cycle with reheat, air at state \((p_1, T_1)\) is compressed to pressure \(p_2\) 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

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

5(a) Discuss the Exhaust blowdown losses and pumping losses in an actual 4-stroke cycle engine. Compare the extent of these losses in SI and CI engines.

5(b) In a limited pressure cycle, compression ratio is 18:1 and suction takes place at 1 bar and 25 °C. Index for compression is 1.33. the fuel used is \(C_7\ H_{16}\) having calorific value 42.5 MJ/kg.

If \((Q_s)_{cv} = \frac{1}{2} (Q_s)_{cp}\), find the maximum pressure and maximum temperature in the cycle with and without molecular expansion.

Take the air-fuel ratio as 25:1 and \(C_p = 1.25 \text{ kJ/kgK}, \ C_v = 0.75 \text{ kJ/kgK}\)

5' Compute the cycle temperatures and pressures, the net efficiency and the net mean effective pressure of an engine that operates on the ideal Otto cycle with ideal four stroke intake and exhaust, whose specifications are

Compression ratio = 10
Induction temperature = 305 K
Exhaust pressure = 1 atm
Heat added = 2515 kJ/kg
Adiabatic index = \(\gamma = 1.25\)
Inlet to exhaust pressure ratio = 0.5
Molecular weight = 29
2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
MANUFACTURING SCIENCES (ME303)
MANUFACTURING TECHNOLOGY II (ME 325)

Maximum Marks: 60                      Credits: 05                      Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning. Draw neat sketches to support your answers.

1(a) Explain the precautions taken in machining with brittle tool materials, especially ceramics. [3]

1(b) Calculate the total energy spent in the shear plane during a plain turning operation on a lathe under the following conditions:
   Depth of cut = 0.20 mm
   Width of cut = 6mm
   Chip thickness = 0.2 mm
   Cutting speed = 2.5 m/s
   Tool signature = 0°, 15°, 7°, 8°, 20°, 0°, 7 mm
   Cutting force = 600 N
   Thrust force = 300 N [9]

2(a) Discuss the force or torque required in drilling if (a) the depth of hole is increased and (b) diameter of hole is increased. Assume all other cutting parameters as constant. [3]

2(b) A high speed steel block of 100 mm width and 600 mm length is milled by using slab milling machine. The feed and the depth of cut are 0.15 mm/tooth and 3 mm respectively. The diameter of the cutter is 60 mm rotating at a speed of 120 rpm and has eight straight teeth. Calculate maximum chip thickness, material removal rate, time of cut and power required if the specific energy is 7.3 W-s/mm³. [9]

OR

2’ Write short notes on the following: [4 x 3]
   (i) Shot peening and laser peening.
   (ii) Roller burnishing
   (iii) Mechanical plating
   (iv) honing

Contd…..2.
A. Write preparatory / miscellaneous functions of any four of the following: [2]
(a) M03
(b) M09
(c) N010
(d) G71
(e) G94
(f) G91

B. Give G – M code of any four of the following: [2]
(i) Rapid traverse, positioning
(ii) Circular interpolation, clockwise
(iii) Return to machine zero
(iv) Program stop (Temporary)
(v) Constant surface speed
(vi) Tool change

OR

3 (a') How is an industrial robot defined? Identify three manufacturing situations suitable for robot applications. Give reasons for your answer. [4]

3(b) Develop a program to turn a bar of 50 mm diameter 150 mm long to the following product, Figure 1. Feed rate should not exceed 0.5 mm/revolution and maximum depth of cut can be 2 mm. Give the details of each block used [8]

All dimensions are in millimetres.

OR

3' (Only those students who are appearing for ME303)
Describe the working principles of electrochemical machining. Discuss the effect of physical properties of the work material on the properties of machined surface. Also

Contd....3.
discuss the properties of work materials to machine through electrochemical machining process.

4(a) What are Airy points? State the conditions to achieve this.

4(b) Differentiate between accuracy and precision. Discuss the relationship between accuracy and cost?

4(c) Define the terms allowance and clearance.
The tolerances for a hole and shaft assembly having a nominal size of 40 mm are as follows: hole $40_{+0.021}^{-0.040}$ mm and shaft $40_{-0.075}^{-0.040}$ mm.
Determine the allowance and type of fit.
Also, design the GO and NO-GO gauges for the shaft. Sketch the gauges and mark the dimensions on it.

OR

4'(a) Explain the principle of a Clinometer. Clinometers are generally used for measuring angles, straightness and parallelism and not angles. Why?
4'(b) What are material standards? Discuss the relative merits and demerits of line and end standards.

4'(c) Write a short note on slip gauges. A selection of slip gauges is required to build a height of 48.155mm. Propose the best combination of gauges using a standard set of 56 gauges.

5 Answer any 3 of the following:

(a) With the help of a suitable diagram explain the working of a sigma comparator.

(b) A slip gauge is being tested with the help of a reference gauge and following is the test result:
   Number of fringes on each gauge = 10;
   Width of each gauge = 20 mm
   Distance between the two gauges = 50 mm
   Wavelength of light source = 0.00005mm
   Height of reference gauge = 25 mm
Determine the height of the test gauge.

(c) Differentiate between two wire and three wire methods for the measurement of effective diameter. Determine the effective diameter of a metric screw using a three wire method. The following data is available:
   Diameter of the best size wire = 0.740mm
   Distance over the wires = 25.58mm
   Pitch = 1.25 mm

(d) Describe a gear tooth vernier and indicate how the tooth thickness is checked with this instrument. Calculate the settings of a gear tooth vernier for checking a spur gear having 50 teeth with module 3mm.
2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
MECHANICAL
FLUID MECHANICS II
ME-332

Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

Q.No. Question M.M.
1(a) What is the superposition principle? Using superposition of uniform flow and [6]
doublet, obtain the expression for the coefficient of pressure for the incompressible,
potential flow past a cylinder.
1(b) Consider a 2D, incompressible, irrotational flow with \( \phi = r^n \cos(n\theta) \). Obtain,
(i) the velocity components \( v_r \) and \( v_\theta \)
(ii) the stream function
(iii) the stagnation point(s) for \( n > 1 \)
(iv) the equation for stagnation streamline(s) for \( n = 3 \). Also sketch the stagnation
streamlines for \( n = 3 \).

2(a) For flow of air through a normal shock, the upstream conditions are \( V_1 = 600 \) [6]
m/s, \( T_{01} = 500 \) K, and \( p_{01} = 700 \) kPa. Compute the downstream conditions \( M_2, V_2, \)
\( T_2, p_2, \) and \( p_{02} \).

2(b) Air enters a 3-cm diameter pipe 15 m long at \( V_1 = 73 \) m/s, \( p_1 = 550 \) kPa, and \( T_1 = 60^\circ \text{C} \). The friction factor is 0.018. Compute \( V_2, T_2, p_2, \) and \( p_{02} \) at the end of the pipe. How much additional pipe length would cause the exit flow to be sonic?

OR

2'(a) Air enters a constant-area duct at \( p_1 = 90 \) kPa, \( V_1 = 520 \) m/s, and \( T_1 = 558^\circ \text{C} \). It [6]
is then cooled with negligible friction until it exists at \( p_2 = 160 \) kPa. Estimate (a)
\( V_2; (b) T_2; \) and (c) the total amount of cooling in kJ/kg.

Contd.....2.
2'(b) A bend in the bottom of a supersonic duct flow induces a shock wave which reflects from the upper wall, as in Fig. Compute the Mach number and pressure in region 3.

![Diagram](image)

3 Using the Navier-Stokes equation, derive the Reynolds averaged Navier-Stokes equation for incompressible flow.

With regards to turbulence modelling, explain closure problem. How many additional unknowns are introduced in the momentum equations for the mean flow.

4(a) Consider the N-S equations for the 3D incompressible, homogenous flow given as,

\[
\frac{\partial \mathbf{v}}{\partial t} + \mathbf{V} \cdot \nabla \mathbf{v} + \nabla (\mathbf{v} \cdot \mathbf{v})/2 = -\frac{1}{\rho} \nabla p + \nabla^2 \mathbf{v}.
\]

Taking curl of the above equation and using vector identities, obtain the Vorticity Transport Equation (VTE) for the flow. Also simplify the Vorticity Transport equation for a 2D flow with conservative body forces.

OR

4'(a) (i) Obtain the following equation for u-velocity for the viscous flow of a fluid contained between two parallel plates, h distance apart, with the lower plate fixed and the upper plate moving with a constant velocity \(U_o\) parallel to the plate:

\[
u = (y/h) U_o - h^2/(2 \mu) \left( \frac{\partial p}{\partial x} \right) \left( y/h \right) (1 - y/h)
\]

(i) For the above case find the value of the pressure gradient for zero shear stress at the lower plate when the upper plate moves with 20 m/s and the separation between the plates is 5 cm. Take viscosity of the fluid, \(\mu = 6.0 \times 10^{-2}\) kg/(m.s).

Contd.....3.
4(b) Consider a 2D incompressible flow induced in a stationary homogenous fluid by an impulsively started, steadily moving plate at a velocity $U$ along its length (Stokes I problem). Starting with continuity and momentum equations for 2D incompressible flow, obtain the governing equation(s) and the associated boundary / initial conditions for the flow. Also indicate how a similarity solution can be obtained.

5(a) Consider a boundary layer flow over a flat surface with pressure gradient in the outer flow. Sketch the typical $u$ and $v$ velocity profiles across the boundary layer for favorable and adverse pressure gradients. Explain the difference (if any) in the profiles for adverse / favorable pressure gradients.

5(b) For the boundary layer equation for the flat plate at zero angle of incidence, using the transformation for the stream function $\psi = \sqrt{v \nu U_\infty} f(\eta)$ where $\eta = y \sqrt{U_\infty / v \nu}$, obtain the expression for $u$ and $v$ velocity components in the boundary layer. For a boundary layer flow over a flat plate of length 1.0 m with main stream velocity of 15 m/s, find the stream wise and transverse velocities $u$ and $v$ at a point $y=0.001$ m away in $y$-direction at a distance of $x=0.25$ m from the leading edge. Take $v = 15 \times 10^{-6}$ m$^2$/s and $(f' = 0.63, f = 0.65)$ for $\eta = 2.0$.

OR

5'(b) Von-Karman’s Momentum-Integral Equation for the boundary layer flow over a surface is given as:

$$ d(U_\infty^2 \delta_z)/dx + \delta_1 U_\infty dU_\infty/dx = \tau_y/\rho $$

Using the above equation and an approximate velocity profile in the boundary layer over a flat plate at zero angle of incidence in the form, $u = A_1 + A_2 \sin(A_3 y)$

Find

(i) The constants $A_1$, $A_2$ and $A_3$

(ii) the displacement thickness $\delta_1$ and skin friction coefficient $C_f$
Assume data suitably, if required.
Notations used have their usual meaning.

1(a) An old wooden bridge over a bay is in danger of collapse. The highway department is currently considering two alternatives to alleviate the situation and provide for expected increases in future traffic. One plan is a conventional steel bridge, and the other is a tunnel under the bay. The department is familiar with bridge construction and maintenance but has no experience with maintenance costs for tunnels. The following data has been developed for the bridge:

First Cost: $170000
Painting every 6 years: $10000
Deck resurfacing every 8 years: $30000
Structural overhaul at the end of 12 years: $40000
Annual maintenance: $3000

The tunnel is expected to cost $240000 and will require repaving every 8 years at a cost of $20000. Both designs are expected to last 20 years with negligible salvage value. Since the tunnel under bay would require less supervision it would be preferred by the highway department. Determine the additional equivalent annual amount, if any, for maintenance that could be permitted for the tunnel if the present worth for both the alternatives is same. (i=8% per annum)

1(b) What are the different types of market segments? Explain the phenomenon of inflation and explain it with the help of supply-demand curve

OR

1'(a) A machine was purchased 5 years ago for Rs.100000. Its annual maintenance expense has been Rs.5000 per year. At the end of three years, Rs.9000 were spent on maintenance. At the end of five years (now), the machine is sold for Rs.120000. During the period of ownership the machine was rented for Rs.10000 per year paid at the beginning of each year. Find the Annual Worth of this investment when the interest rate is 12% per year.

Contd.....2.
1(b) Consider the following cash flow series. What value of C makes the deposit series equivalent to the withdrawal series at an interest rate of 12% compounded annually?

<table>
<thead>
<tr>
<th>EOY</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposits (In $)</td>
<td>1000</td>
<td>800</td>
<td>606</td>
<td>400</td>
<td>200</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Withdrawals (in $)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>C</td>
<td>2C</td>
<td>3C</td>
<td>4C</td>
<td>5C</td>
<td>6C</td>
<td>-</td>
</tr>
</tbody>
</table>

2(a) A grinder was purchased 3 years ago for $40,000. It has provided adequate service, but an improved version is now available for $35,000 that will reduce operating costs and cut inspection expenses. Costs and salvage values for the two machines are shown below. Costs that are the same for either machine are not included. Also, the operating costs for the challenger are very low due to warranted equipment. Should a replacement be made if the required rate of return is 15% and the service of the grinder will be needed for only 4 more years?

<table>
<thead>
<tr>
<th>Year</th>
<th>Defender D</th>
<th>Challenger C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operating Cost ($)</td>
<td>Salvage Value ($)</td>
</tr>
<tr>
<td>0</td>
<td>-</td>
<td>12000</td>
</tr>
<tr>
<td>1</td>
<td>3400</td>
<td>7000</td>
</tr>
<tr>
<td>2</td>
<td>3900</td>
<td>4000</td>
</tr>
<tr>
<td>3</td>
<td>4600</td>
<td>2500</td>
</tr>
<tr>
<td>4</td>
<td>5600</td>
<td>1000</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

2(b) An asset for drilling was purchased and placed in service by a petroleum production company. Its cost Basis is Rs 60000 and it has an estimated Market value of Rs, 12000 at the end of an estimated useful life of 14 years. Compute the depreciation amount in the third year and the Book Value at the end of the Fifth year by using (i) Straight line method (ii) Double Declining Balance Method.

3(a) Differentiate the working of managers by level and area in an organization.

3(b) What are the three basic areas of concern for managerial ethics? Explain.

3(c) Explain the different decision making environments with suitable examples.

4(a) Define “Control” as a function of management and explain its purpose.

4(b) Describe the Managerial Grid and explain the different kind of leadership styles.

4(c) Define Motivation and explain Hertzberg’s theory of motivation.

OR

_Contd.....3._
4'(a) Differentiate between the following:
   (i) Power and authority
   (ii) Hierarchy and chain of commands
4'(b) Differentiate between strategic and operational plans with suitable examples.
4'(c) What is the need for coordination? What are its different forms? Explain any one.

5(a) Derive an expression for economic order quantity. Explain the various costs considered in the model.
5(b) Differentiate between income statement and balance sheet. Define any two financial ratios.
5(c) What is internationalization of an organization? Explain any two alternatives.