USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are FOUR questions in this section. Answer any THREE.

Make reasonable assumptions in case of any missing data.

1. (a) Derive the Reynolds Transport Theorem,

\[
\frac{dN}{dt}_{\text{system}} = \int_{C_V} \eta \rho d\mathbf{V} + \int_{CS} \eta \rho \mathbf{V} \cdot d\mathbf{A}
\]

where symbols have their usual meaning. Hence, discuss the physical interpretation of each term of the equation.

(b) A small rocket, with an initial mass of 500 kg, is to be launched vertically. Upon ignition the rocket consumes fuel at the rate of 6 kg/s and ejects gas at atmospheric pressure with a speed of 3700 m/s relative to the rocket. Determine the initial acceleration of the rocket, if air resistance is neglected.

2. (a) Derive the differential forms of the momentum equation for any fluid in Cartesian coordinate system,

\[
\rho g_x + \frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z} = \rho \left( \frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} \right)
\]

\[
\rho g_y + \frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \tau_{yy}}{\partial y} + \frac{\partial \tau_{zy}}{\partial z} = \rho \left( \frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} \right)
\]

\[
\rho g_z + \frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \frac{\partial \tau_{zz}}{\partial z} = \rho \left( \frac{\partial w}{\partial t} + u \frac{\partial w}{\partial x} + v \frac{\partial w}{\partial y} + w \frac{\partial w}{\partial z} \right)
\]

(b) A liquid flows down an inclined plane surface in a steady, fully developed laminar film of thickness \(h\). Simplify the continuity and Navier-Stokes equations to model this flow field. Obtain expression for the liquid velocity profile, the shear stress distribution, the volume flow rate, and the average velocity. Relate the liquid film thickness to the volume flow rate per unit depth of surface normal to the flow. Calculate the volume flow rate in a film of water \(h = 1\) mm thick, flowing on a surface \(b = 1\) m wide, inclined at \(\theta = 15^\circ\) to the horizontal.

Contd ……….. P/2
3. (a) Derive the expression of velocity distribution, \( u \); shear stress distribution, \( \tau_{xy} \); volume flow rate, \( Q \); and the point of maximum velocity for the flow between two infinite parallel plate when second plate is moving parallel to the first plate with a constant speed, \( U \).
(b) Write short note on major and minor losses for pipe flow.

4. (a) With necessary schematic, discuss the working principle of a pelton wheel.
(b) Show that the efficiency of the pelton wheel is maximum when the velocity of the buckets equals half the velocity of the jet.
(c) Define turbine specific speed. Draw the specific speed vs. max. efficiency curve for three main types of dynamic turbine.

SECTION – B
There are FOUR questions in this section. Answer any THREE.

5. (a) State and explain the shear stress vs. deformation diagram of ideal, Newtonian and Non-Newtonian fluids.
(b) A cylindrical shaft of 90 mm diameter rotates concentrically at 60 rpm inside a cylinder of 91.5 mm diameter as shown in Fig. for Q. No. 5(b). Both the shaft and the cylinder are 1.0 m long. If the torque required to rotate the shaft is 1.6 N-m, find the viscosity of the oil occupying the annular space.
(c) Calculate the pressure at point A, B, C and D shown in Fig. for Q. No. 5(c) in pascals.

6. (a) What depth of water will cause the rectangular gate to fall as shown in Fig. for Q. No. 6(a). Neglect the weight of the gate.
(b) An open cylindrical tank of 0.6 m high and 0.4 m in diameter is rotated about its vertical axis. The tank is full of water. (i) Calculate the speed at which the water surface touches the center of the bottom of the tank, (ii) Also calculate the level to which the water will return when the tank stops spinning and the amount of water spilled out.

7. (a) What is metacentric height? Discuss the stability of floating and submerged bodies.
(b) To what depth will a 2 m diameter log of 5 m long and specific gravity of 0.6 sink in fresh water?

8. (a) Water flows at the rate of 150 liter/sec through a reducer as shown in Fig. for Q. No. 8(a). Find the deflection "h" in the mercury manometer. Neglect frictional losses.
(b) Write short notes on the followings (Any two):
   (i) NPSH of a centrifugal pump.
   (ii) Typical characteristics curves of a centrifugal pump.
   (iii) Series and Parallel connections of centrifugal pumps.
Equations for Ques. No. 2 (b)

\[ \rho \left( \frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} \right) = -\frac{\partial p}{\partial x} + \mu \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right) \]

\[ \rho \left( \frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} \right) = -\frac{\partial p}{\partial y} + \mu \left( \frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 v}{\partial z^2} \right) \]

\[ \rho \left( \frac{\partial w}{\partial t} + u \frac{\partial w}{\partial x} + v \frac{\partial w}{\partial y} + w \frac{\partial w}{\partial z} \right) = -\frac{\partial p}{\partial z} + \mu \left( \frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} + \frac{\partial^2 w}{\partial z^2} \right) \]
SECTION - A

There are FOUR questions in this section. Answer any THREE.

1. (a) What is meant by tool designation? Prove by master line method for a single point cutting tool,
   \[ \tan \gamma_0 = \tan \gamma_s \sin \phi + \tan \gamma_y \cos \phi \]
   \[ \tan \lambda = -\tan \gamma_s \cos \phi + \tan \gamma_y \sin \phi \]
   where the notations indicate their usual meanings.

   (b) With the help of a suitable diagram, explain what is meant by shear strain. Based on that diagram derive an expression to visualize the dependence of shear strain on tool rake angle, chip velocity and cutting velocity in turning.

   (c) If a mild steel rod is turned at feed of 0.32 mm/rev. by tool of geometry 0°, 12°, 6°, 6°, 20°, 45°, 0 (mm) and chip thickness becomes 0.64 mm, then determine the chip reduction coefficient and shear angle.

2. (a) With the help of Earnest and Merchant model, show that \( P_z = 2\tau_s S_0 \cot \beta \), where the notations indicate their usual meaning.

   (b) SAE 133 cold rolled steel rod of 200 mm diameter is turned at a speed of 650 rpm, feed of 0.25 mm/rev. and 6.00 mm depth of cut by a tool having rake angle 20° and principal cutting edge angle 60°. It was noted that the magnitudes of the tangential component \( (P_s) \) and the axial component \( (P_n) \) of the cutting force 1000 N and 347 N respectively and the value of chip reduction coefficient is 1.732. Using MCD, determine the values of \( \mu \), \( P_s \) and \( P_n \).

   (c) What mechanisms of wear do cutting tools undergo during their use in machining? What properties should a cutting tool materials essentially posses and why?

3. (a) With the help of simple sketch, describe the working principle of Abrasive Jet Machining (AJM). List the advantages and limitations of AJM.

   (b) Explain the principle of operation of Ram type Electrical Discharge Machining (EDM) with necessary sketch. What are the functions served by the dielectric fluid in EDM?

   (c) What are the functions of an electrolyte? What factors need to be considered while selecting it? Discuss the advantages and limitations of some electrolytes.
4. (a) With the help of suitable sketches, explain the following molding process for plastic manufacturing.

   (i) Blow molding
   (ii) Sheet molding compound
   (iii) Transfer molding

(b) With the help of suitable sketch, describe the different section of an injection molding machine. What are the functions of gates in injection molds?

(c) With the help of simple diagram explain the common defects in injection molding and methods of eliminate them.

5. (a) Explain cutting process of non-standard thread in a lathe machine.

(b) In which method of taper turning do you need to disengage the feeding screw of cross-slide? Explain the method with necessary sketch(es).

(c) What are the important properties of abrasives and grinding wheel?

(d) Is it possible to drill a hole in lathe machine? Justify.

6. (a) Explain Honning and Superfinishing process in detail.

(b) Draw different views of a double flute twist drill and explain different features of the tool.

(c) What do you understand by indexing? Discuss the gear cutting process by milling machine.

(d) Discuss Fly cutting process in detail.

7. (a) Derive an expression for optimum cutting speed in order to minimize machining cost.

(b) Discuss Up milling and Down milling process in detail.

(c) What is strain back effect? How does clapper box mechanism acts to support the effect.

(d) Discuss different types of screw threads with necessary sketches.

8. (a) Explain the principle of operation of Electrochemical Machining (ECM) with necessary sketch. List the advantages of ECM.

(b) With the help of suitable sketch, explain briefly the operating principles of rotational molding. List the different types of rotational molding machine.

(c) With the help of suitable sketches, explain the following:
   (i) Electron Beam Machining
   (ii) Thermoforming
SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Find all local maxima, local minima, and saddle points for

\[ f(x_1, x_2) = x_1^2 x_2 + x_2^3 x_1 - x_1 x_2 \]

(b) Solve the problem

\[ \min_x x_1 + x_2 \quad \text{subject to} \quad x_1^2 + x_2^2 = 1 \]

by eliminating the variable \( x_2 \). Show that the choice of sign for a square root operation during the elimination process is critical; the "wrong" choice leads to an incorrect answer.

(c) A company is planning to spend $10,000 on advertising. It costs $3,000 per minute to advertise on television and $1,000 per minute to advertise on radio. If the firm buys \( x \) minutes of television advertising and \( y \) minutes of radio advertising, then its revenue in thousands of dollars is given by \( f(x, y) = -2x^2 - y^2 + xy + 8x + 3y \). How can the firm maximize its revenue?

2. Consider the following problem.

Minimize \( W = 5y_1 + 4y_2 \),

subject to

\[
\begin{align*}
4y_1 + 3y_2 &\geq 4 \\
2y_1 + y_2 &\geq 3 \\
y_1 + 2y_2 &\geq 1 \\
y_1 + y_2 &\geq 2 \\
y_1 &\geq 0, \quad y_2 \geq 0.
\end{align*}
\]

Because this primal problem has more functional constraints than variables, suppose that the simplex method has been applied directly to its dual problem. If we let \( x_5 \) and \( x_6 \) denote the slack variables for this dual problem, the resulting final simplex tableau is:

<table>
<thead>
<tr>
<th>Basic Variable</th>
<th>Eq.</th>
<th>Coefficient of:</th>
<th>Right Side</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( Z )</td>
<td>( x_1 )</td>
</tr>
<tr>
<td>( Z )</td>
<td>(0)</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>( x_2 )</td>
<td>(1)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>( x_4 )</td>
<td>(2)</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Contd ........... P/2
For each of the following independent changes in the original primal model, you now are to conduct sensitivity analysis by directly investigating the effect on the dual problem and then inferring the complementary effect on the primal problem. For each change, apply the procedure for sensitivity analysis to the dual problem (do not reoptimize), and then give your conclusions as to whether the current basic solution for the primal problem still is feasible and whether it still is optimal. Then check your conclusions by a direct graphical analysis of the primal problem.

(a) Change the objective function to \( W = 3y_1 + 5y_2 \).
(b) Change the right-hand sides of the functional constraints to 3, 5, 2, and 3, respectively.
(c) Change the first constraint to \( 2y_1 + 4y_2 \geq 7 \).
(d) Change the second constraint to \( 5y_1 + 2y_2 \geq 10 \).

3. (a) A fair coin is tossed, and the result is shown to player 1. Player 1 must then decide whether to pass or bet. If player 1 passes, then he must pay player 2 $1. If player 1 bets, then player 2 (who does not know the result of the coin toss) may either fold or call the bet. If player 2 folds, then she pays player 1 $1. If player 2 calls and the coin comes up heads, then she pays player 1 $2; if player 2 calls and the coin comes up tails, then player 1 must pay her $2. Formulate this as a two-person zero-sum game. Then graphically determine the value of the game and each player’s optimal strategy.

(b) Consider the general m\( \times \)n, two-person, zero-sum game. Let \( p_{ij} \) denote the payoff to player 1 if he plays his strategy \( i \) (\( i = 1, \ldots, m \)) and player 2 plays her strategy \( j \) (\( j = 1, \ldots, n \)). Strategy \( 1 \) (say) for player 1 is said to be weakly dominated by strategy \( 2 \) (say) if \( p_{1j} \leq p_{2j} \) for \( j = 1, \ldots, n \) and \( p_{1j} = p_{2j} \) for one or more values of \( j \).

(i) Assume that the payoff table possesses one or more saddle points, so that the players have corresponding optimal pure strategies under the minimax criterion. Prove that eliminating weakly dominated strategies from the payoff table cannot eliminate all these saddle points and cannot produce any new ones.

(ii) Assume that the payoff table does not possess any saddle points, so that the optimal strategies under the minimax criterion are mixed strategies. Prove that eliminating weakly dominated pure strategies from the payoff table cannot eliminate all optimal mixed strategies and cannot produce any new ones.

4. (a) Explain memoryless property of exponential distribution with an appropriate example.
(b) Prove that for any state of the queuing system \( n \) (\( n = 0, 1, 2, \ldots \)), mean entering rate = mean leaving rate.
(c) Consider a single-server queuing system where some potential customers balk (refuse to enter the system) and some customers who enter the system later get impatient and renege (leave without being served). Potential customers arrive according to a Poisson process with a mean rate of 4 per hour. An arriving potential customer who finds \( n \) customers already there will balk with the following probabilities:
Service times have an exponential distribution with a mean of 1 hour. A customer already in service never reneges, but the customers in the queue may renege. In particular, the remaining time that the customer at the front of the queue is willing to wait in the queue before reneging has an exponential distribution with a mean of 1 hour. For a customer in the second position in the queue, the time that she or he is willing to wait in this position before reneging has an exponential distribution with a mean of 1/2 hour.

(i) Construct the rate diagram for this queuing system.

(ii) Obtain the steady-state distribution of the number of customers in the system.

(iii) Find the expected fraction of arriving potential customers who are lost due to balking.

(iv) Find \( L_q \) and \( L \).

**SECTION – B**

There are FOUR questions in this section. Answer any THREE.

5. (a) What is model validation? Discuss how it is performed.

(b) Define 'Optimum solution' and 'CPF solution'. What is the relationship between them?

(c) Discuss the assumptions in linear programming.

6. (a) Using the Big M method, work through the simplex method, step by step, to solve the following problem.

Minimize \( Z = 3x_1 + 2x_2 + 4x_3 \),

subject to

\[
2x_1 + x_2 + 3x_3 = 60 \\
3x_1 + 3x_2 + 5x_3 \geq 120
\]

and

\( x_1 \geq 0, \ x_2 \geq 0, \ x_3 \geq 0 \).

(b) The shaded area in the following graph represents the feasible region of a linear programming problem whose objective function is to be maximized.
Label each of the following statements as True or False, and then justify your answer based on the graphical method. In each case, give an example of an objective function that illustrates your answer.

(a) If (3, 3) produces a larger value of the objective function than (0, 2) and (6, 3), then (3, 3) must be an optimal solution.
(b) If (3, 3) is an optimal solution and multiple optimal solutions exist, then either (0, 2) or (6, 3) must also be an optimal solution.
(c) The point (0, 0) cannot be an optimal solution.

7. (a) A cargo plane has three compartments for storing cargo: front, center, and back. These compartments have capacity limits on both weight and space, as summarized below:

<table>
<thead>
<tr>
<th>Compartment</th>
<th>Weight Capacity (tons)</th>
<th>Space Capacity (cubic feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>12</td>
<td>7000</td>
</tr>
<tr>
<td>Center</td>
<td>18</td>
<td>9000</td>
</tr>
<tr>
<td>Back</td>
<td>10</td>
<td>5000</td>
</tr>
</tbody>
</table>

Furthermore, the weight of the cargo in the respective compartment must be the same proportion of that compartment's weight capacity to maintain the balance of the airplane. The following four cargoes have been offered for shipment on an upcoming flight as space is available:

<table>
<thead>
<tr>
<th>Cargo</th>
<th>Weight (tons)</th>
<th>Volume (cubic feet/ton)</th>
<th>Profit ($/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>500</td>
<td>320</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>700</td>
<td>400</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>600</td>
<td>360</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>400</td>
<td>290</td>
</tr>
</tbody>
</table>

Any portion of these cargoes can be accepted. The objective is to determine how much (if any) of each cargo should be accepted and how to distribute each among the compartments to maximize the total profit for the flight. Formulate a linear programming model for this problem.

(b) Consider the transportation problem having the following parameter table:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>1</td>
<td>13</td>
<td>10</td>
<td>22</td>
<td>29</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>14</td>
<td>13</td>
<td>16</td>
<td>21</td>
<td>M</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>M</td>
<td>11</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>18</td>
<td>9</td>
<td>19</td>
<td>23</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>30</td>
<td>24</td>
<td>34</td>
<td>36</td>
<td>28</td>
<td>0</td>
</tr>
</tbody>
</table>

Find initial BF solution using 'Vogel's approximation method', then optimize it using 'Transportation simplex method'.

Contd .......... P/5
8. (a) Pilgrim Haven, retirement resort, has been divided into five tracts. One of the decisions to be made here is where to locate the two fire stations that have been allocated to the community. For planning purposes, no more than one fire station to be located in any given tract. Each station is to respond to all the fires that occur in the tract in which it is located as well as in the other tracts that are assigned to this station. Thus, the decisions to be made consist of (1) the tracts to receive a fire station and (2) the assignment of each of the other tracts to one of the fire stations. The objective is to minimize the overall average of the response times to fires.

The following table gives the average response time to a fire in each tract (the columns) if that tract is served by a station in a given tract (the rows). The bottom row gives the forecasted average number of fires that will occur in each of the tracts per day.

<table>
<thead>
<tr>
<th>Assigned Station Located in Tract</th>
<th>Response Times (in minutes) Fire in Tract</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Average frequency of fires</td>
<td>2 per day</td>
</tr>
</tbody>
</table>

Formulate a BIP model for this problem. Identify any constraints that correspond to mutually exclusive alternatives or contingent decisions.

(b) Use the BIP branch-and-bound algorithm to solve the following problem interactively:

Minimize \[ Z = 5x_1 + 6x_2 + 7x_3 + 8x_4 + 9x_5, \]

subject to

\[ 3x_1 - x_2 + x_3 + x_4 - 2x_5 \geq 2 \]
\[ x_1 + 3x_2 - x_3 - 2x_4 + x_5 \geq 0 \]
\[ -x_1 - x_2 + 3x_3 + x_4 + x_5 \geq 1 \]

and

\[ x_j \text{ is binary, for } j = 1, 2, ..., 5 \]
SECTION – A

There are FOUR questions in this section. Answer any THREE.

1. (a) Briefly describe the different properties of measuring instruments. (10)
   (b) What is measurement error? Mention various sources of measurement error. (8)
   (c) How can you differentiate between a left hand and a right hand thread? Explain briefly. (5)
   (d) What is effective diameter of screw thread? Explain the two wire method. (12)

2. (a) For a screw thread, discuss the relationship between pitch and lead. (5)
   (b) What do you mean by involute function of gear? Derive a mathematical expression for the involute function. (7)
   (c) Explain the procedure of measuring tooth thickness of gear by gear tooth vernier calipers with necessary equations and sketch. (15)
   (d) During chasing Joker, Batman suddenly stopped as he felt something wrong in his vehicle "batmobile". He went to his mechanic in Gotham city. The mechanic found a damaged bevel gear. After proper analysis, the mechanic found out that the gear was under huge pressure as it was unable to reduce the speed as required. Can you suggest which type of gear should be used to fix the batmobile? Justify your answer. (8)

3. (a) In the measurement of surface roughness, height of 20 successive peaks and troughs were measured from a datum and were 35, 25, 40, 22, 35, 18, 42, 25, 35, 22, 36, 18, 42, 22, 32, 21, 37, 18, 35, 20 microns. If these measurements were obtained over a length of 20 mm, determine the CLA and RMS value of the rough surface. (8)
   (b) Describe the stylus probe instrument with necessary figure. (12)
   (c) Tom recently has got hold of a diaphragm and a bellow type pressure switch. No wonder he wants to use them to catch Jerry. To detect the presence of such a small mouse, which type of pressure switch should Tom use? Justify your answer. (7)
   (d) Explain the working principle of LVDT with neat sketches. (8)

Contd ............ P/2
4. (a) Construct the ladder and function block diagram, for \((A \cdot \overline{B} + C) \cdot (E + F) \cdot G + H\).

(b) Construct a ladder diagram for a program that could be used to flash a light on and off as long as there is some output occurring. You have to use two timers, each having preset value of 1s.

(c) Write short notes on latching and pulse timer.

**SECTION – B**

There are FOUR questions in this section. Answer any THREE.

5. (a) What are the basic building blocks of a mechanical rotational system? Derive separate expressions for each building block relating the input torque and the output angular displacement.

(b) Derive the expression of steady-state error for an unity feedback system.

(c) There are two series elements in a system. The transfer functions of two elements are:

\[
G_1(s) = \frac{3}{s + 2} \quad \text{and} \quad G_2(s) = \frac{1}{s^2}
\]

The feed-back path transfer function \(H(s) = 10\). What is the overall transfer function of this negative feedback system.

6. (a) Derive the system equation for first order system for a step input taking into account both the transient and steady state responses. From the system equation, derive the expression for "Time Constant" and "Steady State Gain".

(b) Derive the differential equation for a motor driving a load through a gear system which relates the angular displacement of the load with time.

(c) What is the difference between natural response and forced response?

Contd ............. P/3
7. (a) For a rotational translational system derive the differential equation relating system input and output. (15)

(b) What do you understand by "linearity" in a system? Explain the concept of linearity with a suitable example? (10)

(c) A proportional controller is used to control the height of the water in a tank where the water level can vary from zero to 4.0 m. The required height of water is 3.5 m and the controller is to fully close a valve when the water rises to 3.9 m and fully open it when water falls to 3.1 m. What proportional band and transfer function will be required? (10)

8. (a) Discuss different types of fits. (8)

(b) Why hole basis system of fit is generally employed? (5)

(c) Explain Taylor's principle and its significance with necessary figures. (15)

(d) Shafts of 75 ± 0.02 mm diameter are to be checked with the help of go and not-go snap gauge. Determine the go and not-go gauge dimensions in unilateral and bilateral system. Consider normal wear allowance and gauge maker's tolerance. (7)
SECTION – A

There are FOUR questions in this section. Answer any THREE.
Symbols indicate their usual meaning.

1. (a) Define supply function. (5)
(b) What are the factors that influence the shifting of the supply curve? (10)
(c) From the following demand function, make a hypothetical demand schedule and plot the curve. (10)
   \[ Q = 90 - 20P + P^2 \]
(d) What are the exceptions to the law of demand? Explain them. (10)

2. (a) Define Income elasticity of demand and price elasticity of demand. (10)
(b) How would you measure price elasticity of demand at any point on a straight line demand curve? Explain graphically. (15)
(c) From the following table calculate elasticity of demand if you move from point A to C and explain what you understand from the result. (10)

<table>
<thead>
<tr>
<th>Point</th>
<th>P_x</th>
<th>Q_y</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>500</td>
<td>120</td>
</tr>
<tr>
<td>B</td>
<td>600</td>
<td>150</td>
</tr>
<tr>
<td>C</td>
<td>700</td>
<td>180</td>
</tr>
</tbody>
</table>

3. (a) Make a hypothetical indifference schedule and plot the indifference curve. Explain the properties of an indifference curve. (15)
(b) Explain consumer’s equilibrium with the help of budget line and indifference curve. (10)
(c) From the following budget line and the utility function, calculate the amount of two commodities that maximizes satisfaction. What is the maximum amount of satisfaction? (10)
   \[ 2000 = 15X + 25Y \]
   \[ U = 500X^{0.6}Y^{0.7} \]

4. (a) How is price determined in an economy under competition? What will happen to the price and quantity due to change in demand and supply? (15)
(b) From the following demand and supply functions, calculate equilibrium price and quantity and show the result in a graph. (20)
   \[ P = 0.50Q + 250 \]
   \[ P = -0.40Q + 340 \]
(i) What will happen to the equilibrium price and quantity if government imposes a unit tax of Tk. 15 per unit?
(ii) What will happen if government gives a subsidy of Tk. 15 per unit?
(iii) Describe the change in equilibrium. Show the equilibrium coordinates on the same graph.

SECTION - B

There are FOUR questions in this section. Answer any THREE.

5. (a) Write down the statement of application of Euler's theorem in the theory of distribution of production. How can you show the exhaustion of factor income according to Euler's theorem? (10)
   (b) Discuss the various internal economies of scale of production. (10)
   (c) Define optimization. How can optimization be achieved? Why is optimization necessary with reference to the production of a firm? (15)

6. (a) Make a comparative discussion between perfect competition and monopolistic competition. (5)
   (b) Explain the short-run equilibrium of a firm under monopoly market. (10)
   (c) What is meant by shut-down point of production? Graphically explain the shut-down point of a firm under perfect competition. (10)
   (d) Calculate the profit maximizing level of output and maximum profit from the following total revenue (TR) and total cost (TC) functions:
      \[ TR = 1200Q - 2Q^2 \]
      \[ TC = Q^3 - 61.25Q^2 + 1538.5Q + 2000 \] (10)

7. (a) Describe the circular flow of income and expenditure in a two sector economy. (7)
   (b) Briefly discuss the various methods of measuring national income of a country. (8)
   (c) Calculate national income from the following information:
      \[ GNP = Tk. 1,13,000 \text{ crore} \]
      \[ \text{Depreciation} = Tk. 9,500 \text{ crore} \]
      \[ \text{Indirect tax} = Tk. 12,500 \text{ crore} \]
      Subsidy is 20% of indirect tax. (10)
   (d) Briefly discuss the following policies for controlling inflation with reference to the context of Bangladesh:
      (i) Monetary policy (10)
      (ii) Fiscal policy

8. (a) What do you understand by localization of industries? What are the main causes of localization of industries? (15)
   (b) Explain the advantages and disadvantages of localization of industries. (20)