Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.
Root locus is to be drawn on simple graph paper

Q.No.  Question                                                                                         M.M.
1(a)   Define Servomechanism. Also discuss briefly the characteristics of feed back in a      [05]
       control system.
1(b)   Explain in detail principle of operation of synchro transmitter - receiver as an error   [07]
       detector.

OR

1'(a)  Derive the transfer function of field controlled DC Servomotor. Prove that it is an       [06]
       open loop system.
(b)    Draw the Electrical analogue of the given mechanical system shown in Fig. 1 Use       [06]
       force voltage analogy.

Fig. 1
2(a) Find \( \frac{C(s)}{R(s)} \) of block diagram shown in Fig. 2. Use block diagram reduction technique.

![Block Diagram](image)

**Fig. 2**

2(b) Determine the transfer function of the network shown in Fig. 3. Use Masson's gain formula.

![Network Diagram](image)

**Fig. 3**

3(a) Mention clearly distinct advantages of modern control theory. Also define the following terms:
(i) Controllability.
(ii) Observability.

(b) Obtain state model for the following electrical network shown in Fig. 4.

![Electrical Network](image)

**Fig. 4**
4(a) Sketch the complete root locus of the system whose open loop transfer function is given by:

\[ G(s)H(s) = \frac{K(s-2)}{s^2(s+3)} \]

OR

4'(a) Describe time domain specification of a control system.

(b) A unity negative feedback control system has forward path transfer function

\[ G(s) = \frac{K(s+2)}{s(s+5)(s+4s+1)} \]

The input \( r(t)=1+3t \). Determine minimum value of \( K \) such that steady state error to above input is less than unity.

5(a) Choose the value of \( K \) so that the system is just stable for the following characteristic polynomial:

\[ F(s) = s^4 - KS^3 - (K+4)s^2 - (K-3)s - 4 \]

5(b) Define phase margin and gain margin with reference to Bode plot. Also discuss in detail its physical significance.

OR

5(b') A proportional integral (PI) controller is used to improve the performance of a unity feedback second order system with

\[ G(s) = \frac{\omega_n^2}{s(s + 2\epsilon\omega_n)} \]

Draw the block diagram of the complete system and determine its closed loop transfer function. Also discuss main features of this controller.
Q.No. Question

1(a) During metal cutting, metal shears. Name various shear zones and show them with the help of neat sketches. [02]

1(b) Establish a relation between the shear angle and rake angle during orthogonal cutting. Compute the shear angle for an orthogonal cutting with a single point cutting tool (7°, 8°, 6°, 6°, 0°, 0°, 6 mm) with cutting ratio of 0.6. [04]

1(c) Determine the shear strength of the work material with following data for turning with right hand turning tool:

- Depth of cut = 0.25 mm
- Chip thickness = 1.2 mm
- Width of cut = 2.5 mm
- Tool signature = 0°, 5°, 6°, 6°, 25°, 0°, 6 mm
- Cutting force = 900 N
- Force normal to cutting force = 810 N [06]

OR

1'(a) Define tool life. Give relation between tool life and cutting speed. Discuss the effect of high speed steel and ceramic as tool material on the tool life. [04]

1'(b) A cutting tool can turn 20 pieces of work of same material and of diameter 50 mm after each regrinding. While the tool can be used successfully to turn 50 pieces of the work of diameter 30 mm after each re-sharpening. Compute the number of pieces it will be used to turn work of same material of diameter 40 mm. Also [08]
compute the effect on the production of work of diameter 40 mm if the speed is doubled.

2(a) Show the radial rake angle of straight milling cutter.

2(b) Develop an expression to calculate the average thickness of the chip formed during plain milling using straight cutter.

2(c) In a slab milling operation with straight teeth cutter, the cutter has 15 teeth with 10° rake angle and rotates at 200 rpm. The diameter of the cutter is 80 mm and the table feed is 75 mm/min. The depth of cut is 3 mm. Width of the job is 50 mm and the ultimate shear stress of the work material is 420 N/mm². Let the coefficient of friction between the chip and the cutter be 0.7. Plot the variation of the resultant torque with the rotation. Estimate (i) the average power consumption (ii) the horizontal and vertical components of average milling force. Use Lee and Shaffer’s solution for metal cutting.

OR

2(c') Explain the following processes

(i) Honing
(ii) Gear hobbing
(iii) Thread rolling.

3(a) Determine the machining rate and feed rate in machining iron using electro-chemically using copper electrode and sodium chloride solution (specific resistance = 5 ohm-cm) as electrolyte. Power supply is 25 V and current is 6000 amp, work tool gap is 0.5 cm. Assume density of iron as 7.86 gm/cm³ and Faraday’s constant as 96500.

3(b) Discuss the various merits & demerits of Chemical Machining.

3(c) Explain the Characteristics and Working of LBM with diagram.

4(a) Distinguish between fundamental tolerance and fundamental deviations with reference to ISI practice.

4(b) Explain the principle of spirit level. Derive an expression for its sensitivity.
4(c) What is wringing? How is this property achieved in slip gauges?

4(d) Balls of diameter 30mm and 5 mm were used to measure the taper of a ring gauge. During inspection the ball of 30 mm diameter was protruding by 2.5mm above the top surface of the ring. The surface was located at a height of 50mm from the top of the 5.0 mm diameter ball. Calculate the taper angle.

OR

4'(a) Explain the Taylors principle of limit gauging. Can it be followed strictly in practice? Why?

Design the “GO” and “NO GO” gauges for the shaft-hole pair 25117f8. Given that

(i) upper deviation for the shaft \( f = -5.5 \, \text{D}^{0.41} \)
(ii) 25 mm falls in the diameter step of 18 to 30
(iii) Tolerance value for a nominal diameter of 25mm for IT7 is 21\(\mu\)m and IT8 is 33\(\mu\)m

Sketch the gauges and mark the dimensions on it.

4'(b) Define a fit. What is the basic requirement for a shaft and hole to form a fit? Sketch the disposition of tolerance zones with respect to the basic size for the following:

   (i) Interference fit  (ii) transition fit  (iii) clearance fit

5(a) What is the ‘best size wire’? Find the diameter for the best size wire for a metric thread of pitch 2 mm and thread angle of 60°.

5(b) What is an optical flat? Explain its working principle.

Sketch the fringes that you may expect in the following cases when tested with an optical flat under a monochromatic source of light:

   (i) When the edges of the slip gauges are worn out and the middle surface is optically flat
   (ii) When there is a single high point on the surface of the slip gauge.

5(c) Distinguish between alignment test and performance test of machine tools.

5(d) Discuss the relative advantages and disadvantages of mechanical and electrical comparators.
The dimensions of a four-link mechanism, shown in Fig. 1, are as follows:

\[ AB = 500 \text{ mm}, \ BC = 660 \text{ mm}, \ CD = 560 \text{ mm} \text{ and } AD = 1000 \text{ mm}. \]

The link AB has an angular velocity of 10.5 rad/s counter-clockwise and an angular retardation of 26 rad/s\(^2\) at the instant when it makes an angle of 60\(^\circ\) with AD, the fixed link.

The mass of the links BC and CD is 4.2 kg/m length. The link AB has a mass of 3.54 kg, the center of which lies at 200 mm from A and a moment of inertia \(I = 0.88500 \text{ kg-mm}^2\). Neglecting gravity and friction effects, determine the instantaneous value of the drive torque required to be applied on AB to overcome the inertia forces.
1'(a) The four bar linkage of Fig. 2 has crank 2 driven by an input torque $M_{12}$, an external load $P = 120 \angle 220^\circ$ N acts at point Q on link 4. For a particular position of the linkage shown, find all the constraint forces and their reactions necessary for this position of equilibrium.

![Fig. 2](image)

1'(b) A connecting rod of an I. C. engine has a mass of 2 kg and the distance between the center of gudgeon pin and center of crank pin is 250 mm. The C. G. falls at a point 100 mm from the crank pin along the lines of centers. The radius of gyration about an axis through the C. G. perpendicular to the plane of rotation is 110 mm. Find the equivalent dynamical system if only one of the masses is located at gudgeon pin.

If the connecting rod is replaced by two masses, one at the gudgeon pin and the other at the crank pin and the angular acceleration of the rod is 23000 rad/s$^2$ clockwise, determine the correction couple applied to the system to reduce it to a dynamically equivalent system.

2(a) The crank and connecting rod of a steam engine are 0.3 m and 1.5 m in length. The crank rotates at 180 rpm clockwise. Determine the velocity and acceleration of the piston when the crank is at 40 degrees from the inner dead center position. Also, determine the position of the crank for zero acceleration of the piston.

2(b) The turning moment diagram for a petrol engine is drawn to the following scale:

- turning moment 1 mm = 5 N-m;
- crank angle 1 mm = 1$^\circ$.

The turning moment diagram repeats itself at every half revolution of the engine and the areas above and
below the mean turning moment line taken in order, are 295, 685, 40, 340, 960, 270 mm². The rotating parts are equivalent to a mass of 36 kg at a radius of gyration of 150 mm. Determine the coefficient of fluctuation of speed when the engine runs at 1800 rpm.

3(a) Fig. 3 shows the arrangement of the cranks in a four crank symmetrical engine in which the masses of the reciprocating parts at cranks 1 and 4 each equal to \( m_1 \) and at cranks 2 and 3 are each equal to \( m_2 \).

Show that the arrangement is balanced for primary forces and couples and for secondary forces provided that

\[
\frac{m_1}{m_2} = \frac{\cos \theta_2}{\cos \theta_1}, \quad a_1 = \frac{\tan \theta_2}{\tan \theta_1}, \quad \text{and} \quad \cos \theta_1 \cdot \cos \theta_2 = \frac{1}{2}
\]

![Diagram showing crank arrangement](image)

Fig. 3

3(b) In a three cylinder three crank engine, the reciprocating parts for each cylinder is 900 kg. The length of stroke is 48 cm and the length of connecting rod is 108 cm. The distance between each cylinders along the center line is 72cm. The cranks are set at 120° to each other.

Examine primary and secondary forces and estimate the out of balance primary and secondary couples, when the engines are running at 180 rpm in the clockwise direction.

OR

Contd.....
3(b) Four masses \(m_1, m_2, m_3, \) and \(m_4\) of magnitudes 300, 450, 360 and 390 kg respectively are attached rigidly to a shaft rotating at a uniform speed. Their radii of rotations are 200, 150, 250 and 300 mm respectively. The angles made by these masses from horizontal are \(0^\circ, 45^\circ, 120^\circ\) and \(255^\circ\) respectively. The masses \(m_2, m_3,\) and \(m_4\) are fixed on the shaft at distances of 4, 7, 10 cm respectively from the mass \(m_1\). Find graphically for dynamic balancing

(i) the magnitude of the balancing mass

(ii) the position of the balancing mass if the radius of rotation is 200 mm

4(a) What is meant by effort and power of a governor? Derive the mathematical expression of the effort for a Porter Governor. Assumptions, if any, should be mentioned clearly.

OR

4(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 distance of 40 mm form the governor axis. The mass of each ball is 4 kg and the mass on the sleeve is 40 kg. The balls are attached to the extension of the lower arms which are 100 mm long and are parallel to the governor axis at the minimum radius. The minimum and maximum radii of rotation are 180 mm and 240 mm respectively. Find the corresponding equilibrium speeds.

OR

4(b') Why an auxiliary spring is used alongside main springs in a Wilson-Hartnell governor? Derive the relation between the stiffnesses of the springs and other parameters of the governor with a suitable sketch of the governor. Assumptions, if any, should be clearly stated.

5(a) Discuss the stability of a four wheeled vehicle on a curved road and derive the condition of stability of the vehicle while taking a right turn with suitable diagrams.

5(b) The turbine rotor of a ship has a mass moment of inertia 2000 kgm\(^2\) and it rotates at speed of 3600 rpm in clockwise sense looking from stern. The rotor has a radius of gyration of 0.4 m. Determine

(i) gyroscopic couple and its effect when ship moves at 30 km/hr and steers to the left at a radius of 200m.

(ii) maximum gyroscopic couple and its effect when ship pitches and moving up having amplitude \(10^\circ\) and time period 20 sec. The motion occurs with SHM.
Calculate lower and higher heating values for n-hexane at 25°C, 0.1 MPa on both kilomole and kilogram basis with (i) liquid n-hexane with gaseous water in the products, (ii) gaseous propane with liquid water in the products.

A liquid blend of 80% n-octane (C₈H₁₈) and 20% ethanol (C₂H₅OH) is burned with 400% 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.

OR

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 + 3/2 O₂ → CO₂ + 2 H₂O + 5/2 O₂). If the final temperature is 1000 K, determine the final pressure and the heat transferred from the vessel.

A rigid tank contains a mixture of 1 kmol of H₂ and 0.5 kmol of O₂ at 1 atm, 25°C. After ignition, the final pressure and temperature are 5 atm and 2800 K, with combustion products consisting of H₂O, O₂ and H₂. The equilibrium relation among the products can be expressed as: H₂O ↔ H₂ + 1/2O₂. Calculate equilibrium constant Kₚ and express it in the form of number of moles and pressure P. (Take Gibb's function of formation g°ₙ (kJ/kmol) for H₂, O₂ and H₂O as 0, 0, -89031 respectively.

Contd......
2(a) In a steam power plant working on an ideal reheat-regenerative cycle, steam enters a high pressure (HP) turbine at 8MPa, 480°C. A fraction of steam 'y' is extracted at 2MPa and fed to a closed feedwater heater (CFWH). The rest '1-y' is extracted at 0.7 MPa and reheated to 440°C at the same pressure and then fed to a LP turbine. Both the turbines are connected through a common shaft. Another fraction 'z' is bled off from the LP turbine at 0.3 MPa and is taken into an open feedwater heater (OFWH). The remaining '1-y-z' is condensed at 0.008 MPa in the condenser. The first pump compresses this condensate and sends it to the OFWH at 0.3 MPa, whereas the second pump compresses the saturated liquid water coming out from the OFWH at 0.3 MPa to 8MPa and delivers it to the CFWH, the feedwater leaving the CFWH at 8MPa is then taken to the steam generator. The drained saturated liquid fraction 'y' at 2MPa from the CFWH is fed through a trap 'T' (where throttling occurs) to the OFWH which is at 0.3 MPa. Draw the plant layout of the problem and label the state points.

2(b) 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.

OR

2' In a binary vapour Hg-Steam cycle, saturated Hg vapours enter the turbine at 1250 kPa (\( h_g = 361.2 \, \text{kJ/kg,} \, s_g = 0.5024 \, \text{kJ/kgK} \)) and exhausts at 14 kPa (\( h_f = 36.0 \, \text{kJ/kg,} \, h_f = 294.2 \, \text{kJ/kg,} \, s_f = 0.0923 \, \text{kJ/kgK,} \, s_f = 0.5491 \, \text{kJ/kgK} \)). The mercury condenser/steam generator produces saturated steam at 3.8 Mpa. The steam turbine exhausts at 7 kPa. Determine (i) the work done by Hg and steam turbines, (ii) for a steam flow rate of 25 kg/s, find the Hg flow rate, (iii) combined cycle and individual efficiencies of steam and Hg cycles. Assume sensible heating of water is done in the Hg condenser/steam generator, and no Hg pump work. Draw the cycle on a T-s plot.

Contd…….3
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(a) What do you understand by compounding of steam turbines?

(b) A single-row impulse turbine has blades whose inlet angle is 40° and exit angle 37°. The mean blade speed is 230 m/s and the nozzles are inclined at an angle of 27° to the plane of the rotation of the blades. There is a 10% loss of relative velocity due to friction in the blades. The turbine uses 550 kg/h of steam. Determine (i) the nozzle velocity of the steam, (ii) the absolute velocity of the steam at exit, (iii) the power output of the turbine, (iv) the end thrust on the turbine and (v) the diagram efficiency.

OR

4' (a) Derive an expression for the blade height of an impulse turbine.

(b) 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 and the temperature is 200°C. Determine (i) the specific enthalpy drop across the stage in kJ/kg, (ii) the drum diameter and the blade height if the blade height is 1/10 th of the drum diameter and the steam flow is 100 kg/s and (iii) the % 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.
2012-13
B.TECH. (WINTER SEMESTER) EXAMINATION
(MECHANICAL ENGINEERING)
I.C. ENGINES
ME-324

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 are the essential requirements to be fulfilled by a Fuel Injection system for CI [5]
engines. Discuss various arrangements of a solid injection system used in multi-
cylinder diesel engines.

1(b) The entire output of a supercharged 4-stroke cycle oil engine is used to drive an air [7]
compressor. The air enters the compressor at 20 °C and is delivered to a cooler
which removes heat at the rate of 1340 kJ/min. The air leaves the cooler at 60 °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 60 °C and
1.72 bar. The engine which has 6 cylinders of 90 mm bore and 100 mm stroke runs
at 2000 rpm and delivers an output torque of 147 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

OR

1'(a) With the help of neat sketches, describe various systems of mechanical [4]
supercharging and Turbocharging.

1'(b) Determine the air-fuel ratio at 4570 m altitude in a carburettor adjusted at sea level [4]
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 \( h \) is the height in m and \( t_s \) is sea level temperature in °C.

Contd......2
The air pressure decreases with altitude as per the relation $h = 19220 \ln \left( \frac{1.013}{P} \right)$, where $P$ is in bar. State any assumptions made.

1'(c) A 5 kW, 1500 rpm, single cylinder, 4-stroke diesel engine has a 3 orifice injector. Injection set pressure is 200 bar and the maximum fuel line pressure is expected to reach a value of up to 600 bar at the end of injection duration of 10 °CA. The cylinder gas pressure during injection is expected to vary from 35 bar to 80 bar. If the engine fuel consumption was found to be 0.25 kg/kWh, determine the orifice size. Assume a discharge coefficient of 0.6 and fuel density of 850 kg/m³.

2(a) How does a Real cycle differ from a Fuel-Air cycle? Discuss the effects of various losses encountered in an actual cycle.

2(b) An Otto cycle engine with a compression ratio of 10 uses a petroleum fuel of calorific value 48 MJ/kg. The air-fuel ratio is 15:1. The temperature and pressure of the charge at the end of suction are 57 °C and 1 bar respectively. Determine the maximum pressure in the cycle with mean index of compression as 1.36 and the value of specific heat at constant volume heat addition expressed as $C_v = 0.7117 + 2.1 \times 10^{-4} T$ kJ/kgK, where $T$ is the mean temperature.

If the value of $C_v$ remains constant at 0.7117 kJ/kgK, and also the compression index is unaltered, how will the maximum pressure be affected?

OR

2'(a) What is the significance of Fuel-Air cycles? State the assumptions made in the Fuel-Air cycle analysis. Describe the effects of compression ratio and mixture strength on the thermal efficiency of the cycle.

2'(b) The following data refers to a petrol engine developing 40 kW,

Air-fuel ratio = 15:1, Compression ratio = 6:1, The initial pressure and temperature = 1 bar & 27 °C. The engine fuel is Octane (C₈H₁₈) having calorific value = 44.8 MJ/kg. Find out (i) percentage molecular change (ii) pressure and temperature at the end of combustion with and without molecular change. Take $C_v = 0.71$ kJ/kgK and the law of compression as $PV^{1.3} =$ Constant.

3(a) Explain the phenomenon of Detonation in SI engines. Discuss the effect of various
engine variables on detonation. How does SI engine knocking differ from CI engine knock?

3(b) What are the basic designs of commonly used CI engine combustion chambers. Describe them with the help of neat sketches.

4(a) Discuss the means of improving the specific output and thermal efficiency of an open cycle gas turbine plant.

4(b) A turbo-jet engine flying at a speed of 960 km/h consumes air at the rate of 54.5 kg/s. Calculate: (i) Exit velocity of jet when the enthalpy change for the nozzle is 200 kJ/kg and velocity coefficient is 0.97 (ii) Fuel flow rate in kg/s when air-fuel ratio is 75:1 (iii) Thrust specific fuel consumption (iv) Thermal efficiency of the plant when the combustion efficiency is 93% and the calorific value of the fuel is 45 MJ/kg (v) Propulsive power (vi) Propulsive efficiency (vii) Overall efficiency.

OR

4'(a) What are the fundamental differences between the Jet propulsion and Rocket propulsion systems? Draw the schematic diagram and explain the functioning of liquid bi-propellant rocket engines using pump feed and pressure feed systems. Mention some of the commonly used liquid propellants.

4'(b) A test plant of an open cycle gas turbine consisting of compressor, combustor and a turbine delivers 1475 kW, when operating under the following conditions:

   Compressor inlet temperature and pressure = 15.5 °C and 1 bar
   Isentropic efficiency of the compressor = 0.85
   Conditions at turbine inlet = 620 °C and 4 bar
   Efficiency of the plant = 20 %

Estimate the isentropic efficiency of the turbine and mass flow rate of air.

5(a) What do you understand by “Octane Number” of SI engine fuels? Describe the procedure and test conditions to obtain the Research Octane Number (RON) of a test fuel.

5(b) Discuss important features of non-petroleum fuels used in IC engines.
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.  Question  M.M.
1(a)  How many types of market conditions do you know? Differentiate between  [06]
      monopoly and perfect type of market conditions.

1(b)  A building contractor purchased a dirt scraper for $35000. He maintained the  [06]
      scraper at a cost of $2500 per year. He overhauled the machine 4 years after the
      purchase at a cost of $4000. He sold the scraper for $18000 two years after the
      overhaul. What was his equivalent uniform annual cost if the interest rate was 10%
      per year.

OR

1'(a)  Differentiate between necessities and luxuries.  [02]

(b)  If a machine costs $15000 to purchase and the operating costs are $1000 at the end  [04]
      of the first year, $1200 at the end of the second, and amounts increasing by $200 per
      year through year 12, what is the present worth of the machine if the interest rate is
      15% per year.

(c)  A plant superintendent is trying to decide between the machines detailed below.  [06]
      
      | Machine A          | Machine B          |
      |--------------------|--------------------|
      | First cost $11000  | First cost $18000  |
      | Annual operating  | Annual operating   |
      | cost $3500         | cost $3100         |
      | Major overhaul     | Major overhaul     |
      | $2000/3yr          | $2200/6yr          |
      | Salvage value $1000| Salvage value $2000|
      | Life 5 years       | Life 10 years      |

      Determine which one should be selected on the basis of a present worth comparison
      using an interest rate of 15% per year.

2(a)  Two vans were purchased two years ago for $60000 each. The company plans to  [04]
      keep the vans for 10 more years. Fair market value for a 2 year old van is $42000
      and a 12 year old van is $8000. Annual maintenance costs $12000. Lease cost is
      $9000 per year with annual operating charges of $14000. Should the company lease
      its vans if a 12% per year rate of return is required?

2(b)  What is the difference between declining balance and double declining balance  [04]
      methods of calculating depreciation?
      An asset has a first cost of $25000 and an expected $4000 salvage after 12 years.
      Calculate depreciation and book value for year 4 using the DDB method.
2(c) List the causes and consequences of inflation. What is the impact of inflation on economic evaluations?

3(a) Do you agree that organisations generally have three levels of management represented by top level managers, middle level managers and first line managers? Differentiate among them.

3(b) Research suggests that managers play various roles in an organisation which fall in the categories of interpersonal, informational and decisional. List and explain the roles played in the above said categories.

OR

3'(a) What are the most fundamental skills which a manager should possess to become successful? Explain.

3'(b) Differentiate between Delphi and nominal group decision making techniques. What are the advantages of Group and team decision making?

4(a) List various types of organisation plans. Differentiate between a strategic plan and a tactical plan.

4(b) Are the leadership and management different? If yes, giving suitable examples, distinguish between them.

4(c) Motivation is a great catalyst for achieving desired goals. Explain. What is the two factor theory of motivation?

OR

4'(c) What are the benefits and limitations of job specialisation? Differentiate between job rotation and job enlargement.

5(a) How can you make a reliable forecast? Explain any one quantitative method of calculating forecast.

5(b) Differentiate between a Q/R inventory system and a periodic inventory system.

5(c) What do you understand by marketing mix or 4P's of marketing?

OR

5'(e) What are the 4 basic types of financial statements? Explain any two.
Question

1(a) Enlist the tools of productivity measurement. Discuss how the productivity of labour and capital can be measured.

A wrapping paper company produced 2,000 rolls of paper one day. Standard price is $ 1/roll. Labour cost was $ 160, material cost was $ 50, and overhead was $ 320. Determine the multi-factor productivity.

1(b) Explain how a job shop manufacturing system differs from an assembly line manufacturing system.

1(c) What do you understand by the product development process? List the stages involved in the product development process.

2(a) What are alternative sources of capacity? How do they impact the capacity planning problem?

OR

2'(a) Explain briefly the factors to be considered for facility location. Ten areas as shown in figure below will receive incoming parts from a factory's receiving dock, which can be located at either position A or position B in the facility. The number of loads per month is shown in parentheses. Each department is 5 cm by 5 cm, distance are rectilinear. Which position is best, A or B.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th></th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(50)</td>
<td></td>
<td>(50)</td>
</tr>
<tr>
<td>2</td>
<td>(100)</td>
<td>3</td>
<td>(70)</td>
</tr>
<tr>
<td>5</td>
<td>(40)</td>
<td>6</td>
<td>(80)</td>
</tr>
<tr>
<td>8</td>
<td>(50)</td>
<td>9</td>
<td>(35)</td>
</tr>
</tbody>
</table>

Contd......2
2(b) How is the cycle time determined that is used in balancing the line problems? 

Explain with the help of a suitable example. 

2(c) Differentiate between time study and predetermined time study. 

2(d) Explain the Westinghouse system of rating a worker. 

OR 

2'(c) Differentiate between normal time and standard time. 

2'(d) What is the difference between an operation chart and an activity chart? 

3(a) What is project scheduling? Describe using practical example, the Gantt chart used for project scheduling. 

3(b) What do you understand by network modelling? Describe briefly, any one network based project analysis technique. 

3(c) Using practical example, differentiate between forward and backward operation scheduling. 

OR 

3' What is aggregate output planning? Develop a variable output (production) aggregate plan, using following data for one year as a planning horizon: 

<table>
<thead>
<tr>
<th>Month</th>
<th>Productive days</th>
<th>Forecast (in thousands of units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>05</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>09</td>
</tr>
<tr>
<td>3</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>8</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>9</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>10</td>
<td>21</td>
<td>13</td>
</tr>
<tr>
<td>11</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>18</td>
<td>07</td>
</tr>
</tbody>
</table>

4(a) Explain the meaning of inventory control. Describe the stochastic inventory
modelling approach with the help of examples.

4(b) Describe, any three wastes suggested by Shigeo Shingo to implement JIT system of manufacturing. Use practical examples.

5(a) There are three factories located at X, Y, and Z, that produces some identical products. There are five major distribution points that serve various market areas in A, B, C, D and E. The three factories have capacities that determine the availability of product, and the market demand in the five major areas determines the requirements to be met. Allocate available products at the three factories location to the five distribution points so that demand is met and transportation costs are minimized in the system. The table below shows the resource and cost matrix.

<table>
<thead>
<tr>
<th>Factory</th>
<th>Cost (Rs) per resource unit</th>
<th>Resource Available (in units)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Destinations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>X</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>Y</td>
<td>24</td>
<td>40</td>
</tr>
<tr>
<td>Z</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>Resource Available (in units)</td>
<td>27</td>
<td>16</td>
</tr>
</tbody>
</table>

OR

5'(a) Define the term value. Explain different types of value. What do you mean by value analysis?

5(b) Starting from the initial trial solution \((X_1, X_2) = (0,0)\), apply the gradient search procedure to solve the following problem. Select an error tolerance to perform only three iterations.

Maximize \(f(X) = 2X_1X_2 + 2X_2 - X_1^2 - 2X_2^2\)