

(3 Hours)

Max. Marks: 80

Note:

1. Question 1 is Compulsory
2. Solve any three from remaining five
3. Figures to right indicate full marks
4. Assume suitable data if necessary



Question No.

Max. Marks

- Q.1
- a) Explain Pre and post processing in FEM 5
 - b) Derive shape function for 1D quadratic element in natural coordinates 5
 - c) Explain the significance of Jacobian matrix. 5
 - d) Explain Convergence of results 5

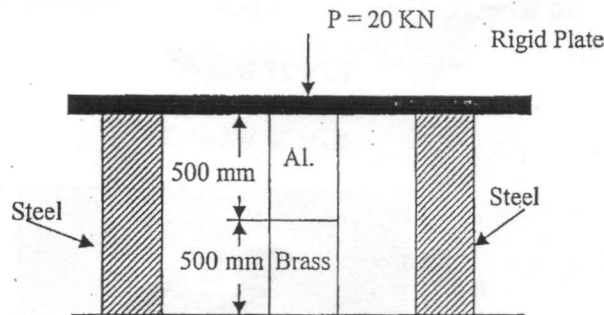
- Q.2
- a) Solve the following differential Equation using Galerkin Method. 10

$$\frac{d^2y}{dx^2} + 3x \frac{dy}{dx} - 6y = 0 \quad 0 < x < 1.$$

Boundary Conditions are: $y(0)=1$, $y'(1)=0.1$

Find $y(0.2)$ and compare with exact solution. 10

- b) For the given, steel blocks supporting rigid plates shown in figure, determine displacement matrix and stresses in each element.

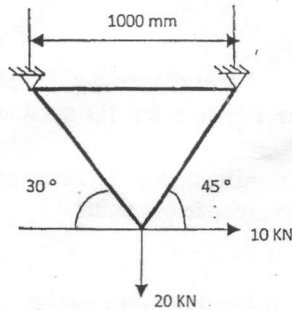


Take:

Properties	Steel	Aluminium	Brass
C/S Area (mm ²)	200	370	370
E (N/mm ²)	2×10^5	7×10^4	8.8×10^4

[TURN OVER

- Q.3 a) What do you mean by consistent and lumped mass matrices? 10
Derive the same for linear bar element.
- b) Consider the truss shown in figure. Given $E = 210$ GPa and 10
cross section area $A = 1$ cm² for each element. Determine
1. Displacement at each node.
 2. Stresses induced in each element.
 3. Reaction at supports

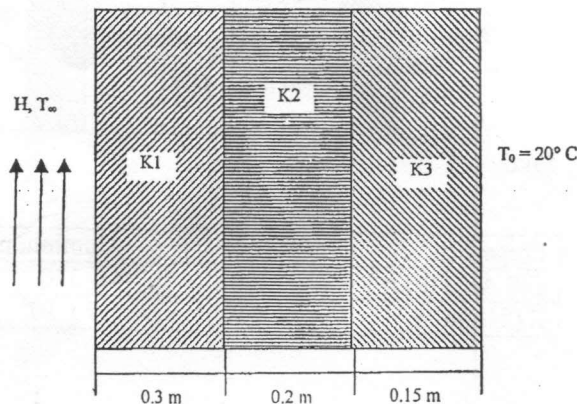


- Q.4 a) It is required to carry out one dimensional structural analysis of 10
a circular bar of length 'L', fixed at one end and carries a point load 'P' at other end. Find the suitable differential equation with required boundary condition (justify) and solve it by using Rayleigh - Ritz method for two linear element.
- b) A composite wall consists of three materials, as shown in figure. 10
The outer temperature $T_0 = 20^\circ\text{C}$. Convection heat transfer takes place on the inner surface of the wall with $T_\infty = 800^\circ\text{C}$ and $h = 30$ W/m² °C. Determine temperature distribution in the wall.

$$K_1 = 25 \text{ W/m-}^\circ\text{C}$$

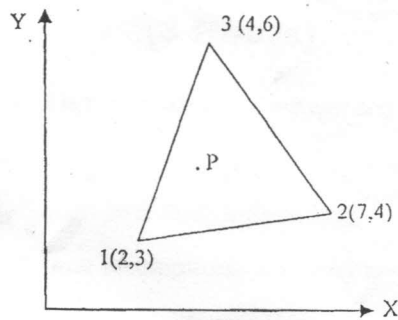
$$K_2 = 30 \text{ W/m-}^\circ\text{C}$$

$$K_3 = 70 \text{ W/m-}^\circ\text{C}$$



[TURN OVER

- Q.5 a) The nodal coordinate of the triangular element are as shown in figure. At the interior point P, the x-coordinate is (4.5) and $N_1=0.3$. Determine N_2 , N_3 and y-coordinate of point P. 10



- b) For a CST element the nodal displacement vector $Q^T = [0, 0, 0, 0, 2, -0.1]$ mm. Find the element stress. Take $E = 200 \text{ GPa}$, plate thickness $t = 5 \text{ mm}$ and Poisson's ratio $\nu = 0.3$. 10
- Q.6 a) What are serendipity elements? Derive and graphically represent interpolation functions for 8 noded Quadrilateral elements. 10
- b) Find the natural frequency of axial vibrations of a bar of uniform cross section of 20 mm^2 and length 1 m . Take $E = 2 \times 10^5 \text{ N/mm}^2$ and $\rho = 8000 \text{ kg/m}^3$. Take two linear elements. 10



Max. Marks : 80
Duration : 3 hours

- Instructions:* 1) Question No. 1 is compulsory
2) Answer any *three* from the remaining five questions
3) Use of recommended *Design data book* is permitted.
4) Use your judgment for unspecified data, if any .

Q. No 1. Solve any **four** of the followings:

- What do you understand by following designations of materials
i) FG350 ii) 40C8 iii) FeE400 iv) 30Ni4Cr1 v) 40Cr1Mo28
- Explain the modes of failures in the mechanical components.
- Why factor of safety is necessary in the design of mechanical components ? . Discuss the important factors influencing the selection of factor of safety.
- 'Curved beams cannot be designed by applying the simple bending theory of straight beams' . Justify the statement.
- What is surging of springs ? . What remedial measures you will suggest to avoid the surging ? .

Q.No.2 a) Design a spigot-socket type cotter joint to transmit an axial load of 42 kN. Select appropriate materials for its components and draw its neat sketch showing major dimensions on it. (14)

- State the following theories of failure and state the relation between yield strength in shear and the yield strength for each of the theory. (2x3=6)
i) Maximum shear stress theory ii) Octahedral shear stress theory

Q.No. 3 a) State the assumptions made in the analysis of curved beams. (4)

- Design a single start square threaded screw for a C-clamp shown in figure 1. The maximum force exerted by the clamp is 5 kN. Use the following data: (16)
i) yield strength of the screw material = 390 N/mm²
ii) shear strength of the nut and body material = 230 N/mm²
iii) coefficient of the screw friction = 0.14
iv) coefficient of the collar friction = 0.16

- v) mean collar radius = 8 mm
 vi) factor of safety = 3
 vii) permissible bearing pressure = 12 N/mm²
 viii) distance between axis of the handle and nut surface, $l = 150$ mm

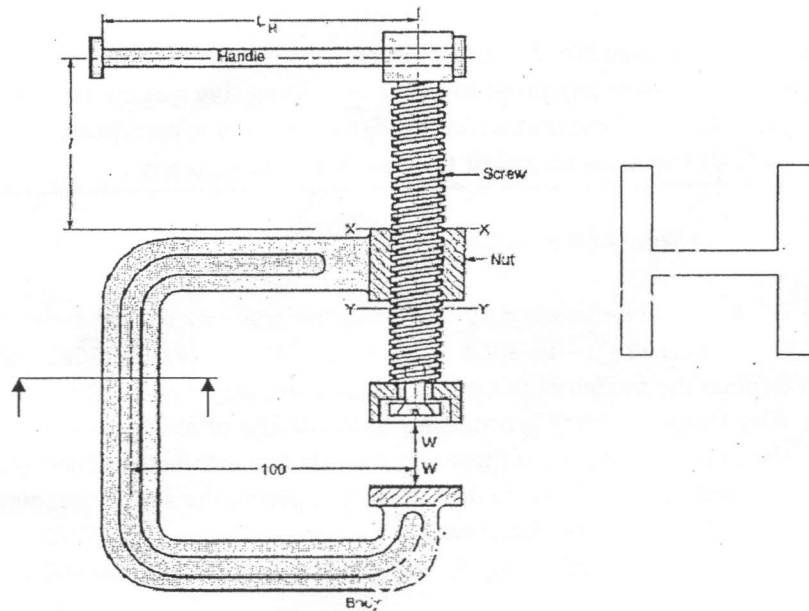


Figure 1 C-clamp

Also, design the I-section as shown by the side of figure 1, taking web = flange = $4t$, where t - thickness of flange and web of the I-section of the clamp body.

Q.No. 4 a) Explain Soderberg diagram and derive equation for a factor of safety based on this concept. (10)

b) The most critical point of component made of steel C40 is subjected to the following variable stresses. Determine the factor of safety based on Soderberg criterion and Octahedral shear theory. (10)

$$\begin{aligned} \sigma_x &- \text{varies from } +12 \text{ to } -10 \text{ N/mm}^2 \\ \sigma_y &- \text{varies from } +14 \text{ to } +6 \text{ N/mm}^2 \text{ and} \\ \tau_{xy} &- \text{varies from } +10 \text{ to } -10 \text{ N/mm}^2 \end{aligned}$$

JP-Con. : 9310-15.

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Q.No. 5 a) A shaft is supported by two bearings placed 1.5 m apart. A 450 mm diameter flat belt pulley is mounted at a distance of 350 mm to the right of LH bearings and drives a pulley directly below it with the help of flat belt having tension on the tight side of 2.8 kN. Another V-groove pulley 300 mm p.c.d. is placed 300 mm to the left of RH bearing and is driven with the help of electric motor and V- belt. The motor is placed horizontally in front. The angle of contact of both the pulley is 180° and $\mu = 0.25$. The angle of V-groove is 35° . Select suitable material for the shaft and determine the diameter of the shaft.

What will be the diameter of the shaft, if it is a hollow shaft with ratio $\frac{d_i}{d_o} = 0.5$?.

Which one will you prefer ? Comment on it. (16)

b) Explain the working of split-muff coupling with neat sketch. (4)

Q.No. 6 a) A helical coil compression spring is to be subjected to a maximum force of 4600 N with a corresponding deflection of 58 mm. The spring is to operate over a 40 mm diameter rod. Determine the wire diameter and number of active turns. Also, decide other details such as free length, pitch, helix angle etc. Check for the solid stress for the material of the spring as follows: (14)

$$S_u = \frac{2000}{d^{0.17}} \text{ N/mm}^2, S_{ys} = \frac{1200}{d^{0.17}} \text{ N/mm}^2 \text{ and } G = 79300 \frac{\text{N}}{\text{mm}^2}.$$

b) Explain any three different types of Keys. (3)

c) What is spring index of a helical spring ? Discuss the significance of it in the design of it. (3)

N.B.:1) Question No.1 is compulsory.

2) Attempt **any three** questions out of remaining five questions.

3) Assume suitable data if necessary.

4) Figures to the right indicate full marks.

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- Q.1** Solve any four (20)
- Define mechatronics and explain factory automation, home and office automation with examples.
 - Distinguish between pneumatic, hydraulic and electrical actuators with its applications.
 - Describe the principle of operation of a D.C. motor.
 - Explain in brief various elements of CNC machine.
 - What is voice coil actuator?
 - Explain Universal Asynchronous Receiver and Transmitter (UART).
- Q.2** (a) How heat dissipation in DC motor is influenced by velocity profile and coupling ratio. (8)
- (b) Two double acting hydraulic cylinders A and B are selected for an industrial application. Draw electro electrohydraulic circuit for the sequence of operation (A+B+ delay B- A-) using 4/3 way double solenoid as the final directional control valve. (12)
- Q.3:** (a) Describe possible speed control strategies of A.C. Induction motors (8)
- (b) Discuss on voltage-torque characteristics of D.C. motor. (8)
- (c) Explain Autonomous Mobile Robot with its applications. (4)
- Q.4** (a) Explain data acquisition system and supervisory control and data acquisition (SCADA). (08)

[PTO]

A Process tank shown in Figure 1 is sequenced to mix liquid fertilizer (12) according to following sequence of operation.

- (b) (i) A start push button is pressed to start the operation and V_1 is being operated to open in order to fill tank up to a preset level sensed by level switch A. (ii) As the tank fills, a level switch A closes NO contact to energize the stirrer motor to start automatically and operate for 5 sec to mix the fluid. (iii) When stirrer motor stops, the solenoid operated water valve V_2 is energized to empty the tank. (iv) When tank is completely empty, the level switch B opens and de-energizes solenoid operated water valve V_2 (v) A Stop button is pressed to stop operation.

Draw PLC ladder diagram to achieve the above sequence of operation.

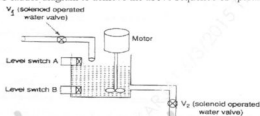


Figure 1

- Q.5 (a) What is the difference between parallel and series interface. (4)
 (b) How data loggers are used in data acquisition system. (4)
 (c) Two double acting cylinders A and B are selected for industrial automation. (12)
 The motion of sequence A+B+(rapid approach) B+(slow feed) B- A-
 Draw Pneumatic circuit diagram and step displacement diagram. Select 5/2 way final directional control valves.
- Q.6 (a) Explain the basic principle of piezoelectric drives and give its applications. (8)
 (b) Explain the working principle of stepper motor and describe its various types along with its applications. (12)



Q.P. Code : 4995

(3 Hours)

[Total Marks : 80

- N.B. : (1) Question No.1 is compulsory.
 (2) Answer any three questions from remaining five.
 (3) Assume suitable data if required.
 (4) Answer to questions showed be poupsed and written together.

1. Answer any four of the following :

20

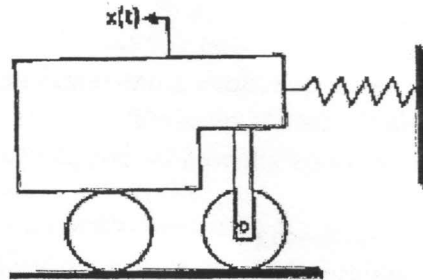
- (a) A spring-mass system has a natural period of 0.25 second. What will be the new period of the Spring constant is :
 (i) increased by 60% and (ii) decreased by 30%?
- (b) A viscously damped spring-mass-damper systems has mass of 10 kg, damping coefficient of 150 N-s/m, and spring stiffness of 1000 N/m. Determine the values of the damping ratio, damped natural frequency logarithmic Decrement
- (c) Two masses of 1kg each are inter connected by a spring of stiffness 10 N/m. Estimate the natural frequencies and draw their corresponding mode shapes.
- (d) A mass is suspended from a spring of stiffness 5000 N/m and is subjected to a harmonic force of amplitude 100 N and a frequency of 10Hz. The amplitude of the forced motion of the mass is found to be 20 mm. Find value of the mass.
- (e) Explain with a neat sketch, the principle of vibration measuring instruments. .
- (f) A rotating unbalance system consists of a disc of mass 2 kg, which is eccentric to the axis of shaft by 2mm. Adding two counter masses of 1kg, each at an axial distance of 1cm. and 2 cm, respectively from either side of the disc, the system is completely balanced. Find the radial location of the counter masses if all the masses lie in the same axial plane.

2. (a) The block Shown has a mass M and slides over two rollers having mass m and radius r each. The stiffness of the spring is k . The second roller is pivoted to a light and stiff rod which is connected to the block at the other end. If the block has a harmonic motion $x(t)$, determine the system's undamped natural frequency.

10

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2. (a)



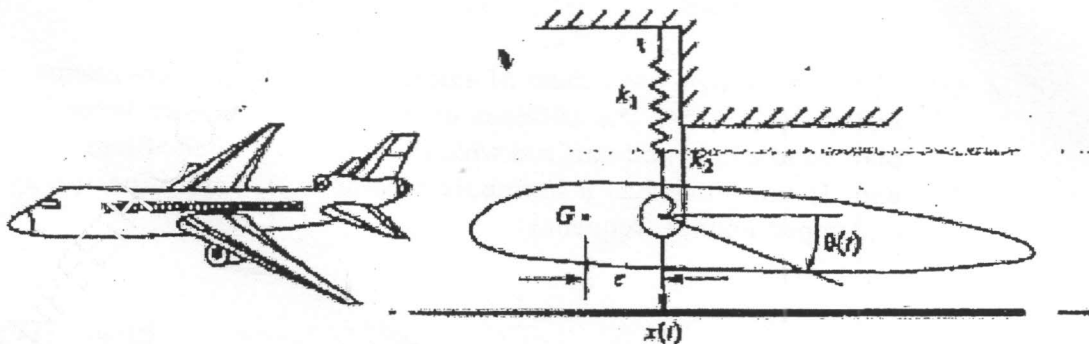
(b) Show that the inertia effect of a shaft of mass moment of inertia J_s can be taken into effect by adding $1/3^{\text{rd}}$ of its value to the mass moment of inertia of the disc J fitted at its end, in order to compute the natural frequency of the system. 5

(c) Define Whirling Speed. Derive the equation for the critical speed of a light shaft with a single disc without damping. 5

3. (a) Explain with a neat sketch, the effect of forcing frequency and damping factor on Displacement Transmissibility. 4

(b) An instrument with mass 13 kg is to be isolated from aircraft engine vibrations ranging from 1,800 to 2,300 cycles per minute. What should be the stiffness of an isolator for at least 65% isolation? Assume that the damping ratio is 0.045. 8

(c) Consider the wing vibration model as shown in the following figure. Using the vertical motion of point attachment of the springs and the rotation of this point, determine the equations of motions using Lagrange's method. G indicates the centre of mass and e denotes the distance between the point of rotation and centre of mass. Ignore the gravitational force. 8

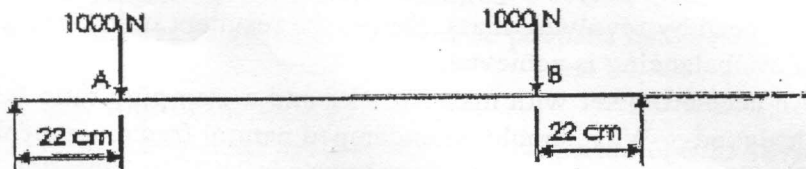


5:

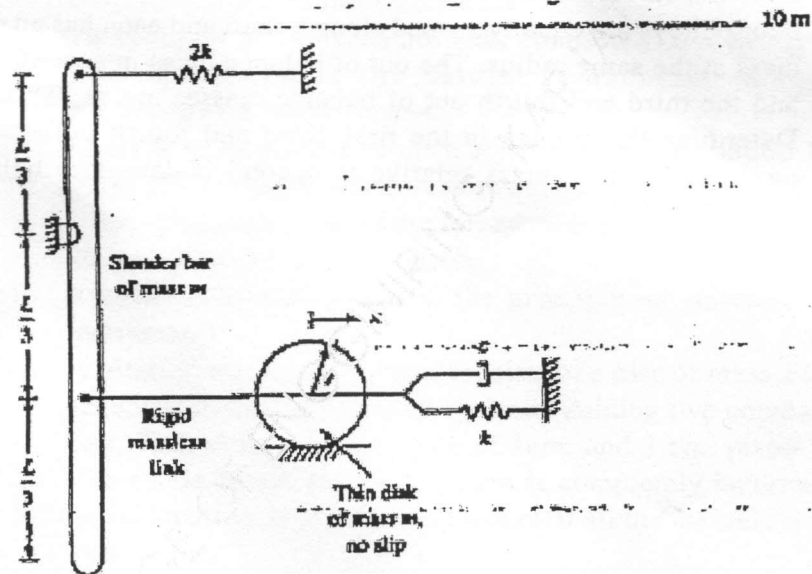
(a)

(b) TURN OVER

4. (a) Determine the frequency of transverse vibration of the beam shown in figure below using Dunkerley's and Rayleigh's energy methods. Deflection at A: due to 1000 N at A = 1.52 mm, due to 1000 N at B = 1.37 mm. 10



- (b) Derive the equivalent system parameters for the following figure, taking x as the generalized coordinate. 10



5. (a) A 2 kg mass connected to a spring of stiffness 1 kN/m has a dry sliding friction force of 2 N. As the mass oscillates, its amplitude decreases 22cm, How long does this take? 5
- (b) Explain why only a part of the unbalance force in reciprocating mass is balanced by revolving mass. Derive the resultant unbalance primary force if $c\%$ balancing is achieved. 5
- (c) An accelerometer with mass 0.01 kg and a damping ratio 0.707 is to be designed. What should be undamped natural frequency of the system so that the measurement error never exceeds 2%? The vibration signal, which is to be measured, can have a frequency as high as 200Hz. 10
6. (a) The natural frequency and the damping ratio of a vibrometer are 6 Hz and 0.22 Hz, respectively. What is range of frequencies for the measurement error to be below 3%? 10
- (b) Four pulleys are equally spaced along a shaft and each has an out of balance mass at the same radius. The out of balance mass in second pulley is 3 kg and the third and fourth out of balance masses are at 75° and 200° to it. Determine the masses in the first, third and fourth pulleys and also the angle of the first mass relative to second if complete balance is to be obtained. 10
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Sem VI / metrology & quality / Engg. / MECH / 12-05-15

Q.P. Code : 4989

(3 Hours)

[Total Marks : 80

- N.B. : (1) Question No.1 is compulsory.
(2) Solve any three out of remaining questions.
(3) Assume suitable data if required and mention it clearly.
(4) Figures to the right indicate marks.



1. (a) State and explain any one most primitive length standards used in measurements. State reasons why these standards were replaced by optical/length standards. 5
(b) What are objectives of quality control. 5
(c) Enlist and explain characteristics of a good comparator. 5
(d) Draw and explain various surface roughness symbols. 5
2. (a) Explain following terms with suitable diagrams 10
(i) Basic size
(ii) Fundamental deviation
(iii) Grades of tolerance
(iv) maximum and minimum metal conditions
(v) Allowance.
(b) Derive necessary expression to calculate the best wire diameter. With the help of suitable diagram explain three wire method used in screw thread measurements. 10
3. (a) Explain construction and working of laser interferometer. 10
(b) How will you maintain compromise between quality and cost. 10
4. (a) Explain following concepts with suitable diagrams. 10
(i) importance of surface conditions
(ii) Roughness and waviness
(iii) Ra value
(b) Explain use of \bar{X} & R charts in quality control. 10

5. (a) Explain construction and working of Parkinson's Tester. 10
- (b) A certain product is given 100% inspection as it is manufactured and the resultant data are summarised by the hour in following table 16 hrs of data is recorded. calculate the central line and variable control limits of P chart using 3-sigma control limits and indicate the values that are out of control. 10

Hour Inspected	No. of units Outside spec.	Number of units
1	48	5
2	36	5
3	50	0
4	47	5
5	48	0
6	54	3
7	50	0
8	42	1
9	32	5
10	40	2
11	47	2
12	47	4
13	46	1
14	46	0
15	48	3
16	39	0

6. Write short notes on : 10
- Tool maker's microscope
 - 3D co-ordinate measuring machine
 - OC curves
 - Double sampling plans.

Course : T.E. (SEM.-VI)(CBSGS) (MECHANICAL
ENGG.)(prog-585 to 598)

Q.P Code:4989

Correction:

1. In Q. 5B ,

Read column no. 2 as no. of units
inspected (instead of no. of units outside
specifications)

Read column no. 3 as no. of units
outside specifications (instead of no. of
units)

2. Q. 6 should be considered for **20 marks**.

Query Update time: 12/05/2015 4:30 PM

Note : take printouts and distribute to concerned students.

Question no.1 is compulsory.

Attempt any **THREE** from question no. 2 to 6.

Use of steam table is permitted.

Fluid Power Engg / 28/05/15



Q1) Solve any **Four**

20

- What is meant by Jet Propulsion? Explain.
- Write a short note on: Classification of water turbine.
- Explain briefly the governing system of a Kaplan turbine.
- Differentiate water tube boilers with fire tube boilers.
- With neat sketch explain the working of closed cycle gas turbine plant.

Q2) a) Explain the working of a Once through boiler with the help of a neat sketch.

08

- b) A 4500 kW gas turbine generating set operates with two compressor stages; the overall pressure ratio is 9:1. A high pressure turbine is used to drive the compressors, and a low pressure turbine drives the generator. The temperature of the gases at entry to the high pressure turbine is 625°C and the gases are reheated to 625°C after expansion in the first turbine. The exhaust gases leaving the low pressure turbine are passed through a heat exchanger to heat air leaving the high pressure stage compressor. The compressors have equal pressure ratios and inter-cooling is complete between the stages. The air inlet temperature to the unit is 20°C . The isentropic efficiency of each compressor stage is 0.8 and the isentropic efficiency of each turbine stage is 0.85, the heat exchanger thermal ratio is 0.8. A mechanical efficiency of 95 % can be assumed for both the power shaft and compressor turbine shaft. Neglecting all pressure losses and changes in kinetic energy calculate:
- the thermal efficiency
 - work ratio of the plant
 - the mass flow in kg/s

Neglect the mass of the fuel and assume the following: $C_p = 1.005 \text{ kJ/kg K}$, and $\gamma = 1.4$

Q3) a) Derive the expression for the condition for maximum blade efficiency in Parson's reaction turbine.

10

- b) A boiler generates 7.5 kg of steam per kg of coal burnt at a pressure of 11 bar, from feed water having a temperature of 70°C . The efficiency of the boiler is 75 % and factor of evaporation is 1.15, specific heat of steam at constant pressure is 2.3 kJ/kg K . Calculate:

10

- Degree of superheat and temperature of steam generated;

- ii. Calorific value of coal in kJ/kg
- iii. Equivalent evaporation in kg of steam per kg of coal

- Q4) a) Obtain the expression for the force exerted by a jet of water on a fixed curved plate when jet strikes at the center of a symmetrical curved plate. 04
- b) Explain the function of following in Reaction water turbine: 06
- i) Guide vane
 - ii) Scroll casing
 - iii) Draft tube
- c) A single stage steam turbine is supplied with steam at 5 bar, 200°C at the rate of 50 kg/min. It expands into a condenser at a pressure of 0.2 bar. The blade speed is 400 m/s. The nozzles are inclined at an angle of 20° to the plane of the wheel and the outlet blade angle is 30°. Neglecting friction losses, determine power developed, blade efficiency and stage efficiency. 10
- Q5) a) Discuss and explain: Methods to improve efficiency of a gas turbine. 06
- b) The three jet Pelton turbine is required to generate 10,000 kW under a net head of 400 m. The blade angle at outlet is 15° and the reduction in the relative velocity while passing over the blade is 5%. If the overall efficiency of the wheel is 80%, $C_v = 0.98$ and speed ratio = 0.46, then find: (i) the diameter of the jet, (ii) total flow in m³/s and (iii) the force exerted by a jet on the buckets. 10
- c) What are the effects of friction in a nozzle? Define nozzle efficiency, coefficient of velocity. 04
- Q6) a) Explain the working of a turboprop engine by means of a sketch. What are its advantages, limitations and applications? 10
- b) In a hydroelectric generating plant, there are four similar turbines of total output 220 MW. Each turbine is 90% efficient and runs at 100 rpm under a head of 65 m. It is proposed to test the model of the above turbine in a flume where a discharge is 0.4 m³/s under a head of 4 m. Determine the size (scale ratio) of the model. Also calculate the model speed and power results expected from the model. 06
- c) Write a short note on boiler mountings. 04