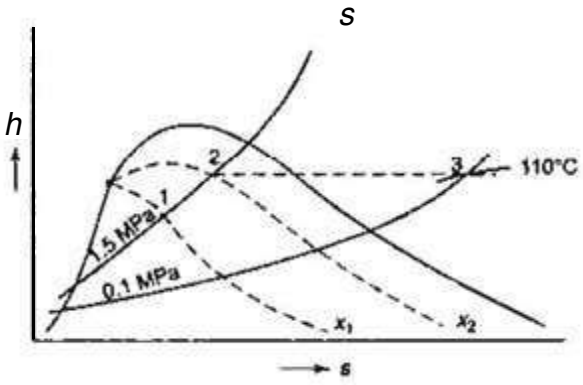
PART–B
MECHANICAL ENGGINEERING

51. The following data were obtained with a separating and throttling calorimeter :

Pressure in pipeline: 1.5 MPa
Condition after throttling: 0.1 MPa, 110°C
During 5 min moisture collected in the separator: 0.150 litre at 70°C
Steam condensed after throttling during 5 min: 3.24 kg

Enthalpy : h_a = 2696.2 kJ/kg,
$h_{f1.5MPa}$ = 844.89 kJ/kg,
$h_{fg1.5MPa}$ = 1947.3 kJ/kg
Specific vol. at 70°C,
V_f = 0.1001023 m^3/kg



Find the quality of steam in the pipeline.

(A) 0.915

(B) 0.845

(C) 0.743

(D) 0.642

52. A mass of 8 kg gas expands within a flexible container so that the *p–v* relationship is of the form $pv^{1.2}$ = constant. The initial pressure is 1000 kPa and the initial volume is 1 m^3. The final pressure is 5 kPa. If the specific internal energy of the gas decreases by 40 kJ/kg, find the heat transfer in magnitude and direction.

(A) +2612 KJ

(B) –2665 KJ

(C) +2665 J

(D) –2612 J

53. Two reversible heat engines A and B are arranged in series, a rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, find

1. The intermediate temperature between A and B
2. The efficiency of each engine
3. The heat rejected to the cold sink

(A) 148.4°C, 40% and 38.5%, 70 kJ

(B) 143.4°C, 50% and 33.5%, 70 kJ

(C) 148.4°C, 50% and 38.5%, 80 kJ

(D) 143.4°C, 40% and 33.5%, 80 kJ

54. Two kg of water at 80°C is mixed adiabatically with 3 kg of water at 30°C in a constant pressure process of 1 atmosphere. Find the increase in the entropy of the total mass of water due to the mixing process (c_p of water = 4.187 kJ/kg K).
(A) 0.05415 kJ/K
(B) 0.04515 kJ/K
(C) 0.05915 kJ/K
(D) 0.05115 kJ/K

55. A turbine operates under steady flow conditions, receiving steam at the following state: Pressure 1.2 MPa, temperature 188°C, enthalpy 2785 kJ/kg, velocity 33.3 m/s, and elevation 3 m. The steam leaves the turbine at the following state: Pressure 20 kPa, enthalpy 2512 kJ/kg, velocity 100 m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of steam flowing through the turbine is 0.42 kg/s, what is the power output of the turbine in kW?
(A) 102.31 kW
(B) 112.51 kW
(C) 105.51 kW
(D) 116.31 kW

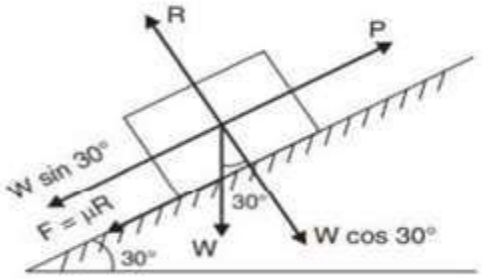
56. A plain slab of thickness δ = 60 cm is made of a material of thermal conductivity k = 17.5 W/m-deg. The left side of the slab absorbs a net amount of radiant energy from a radiant source at the rate of q = 530 watt/m^2. If the right-hand face of the slab is at a constant temperature t_2 = 38°C, Find out the temperature at the mid-plane of the slab. It may be presumed that the temperature distribution is steady and there is no heat generation.
(A) 44.28°C
(B) 47.08°C
(C) 51.18°C
(D) 53.38°C

57. The engine oil at 150°C is cooled to 80°C in a parallel flow heat exchanger by water entering at 25°C and leaving at 60°C. Estimate the exchanger effectiveness and the number of transfer units.
(A) 0.48, 2
(B) 0.51, 3
(C) 0.56, 2
(D) 0.62, 3

58. Saturated steam at 110°C flows inside a copper pipe (thermal conductivity 450 W/m K) having an internal diameter of 10 cm and an external diameter of 12 cm. The surface resistance on the steam side is 12000 W/m^2 and that on the outside surface of the pipe is 18 W/m^2 K. Determine the heat loss from the pipe if is located in space at 25 °C.
(A) 568 W
(B) 578 W
(C) 586 W
(D) 587 W

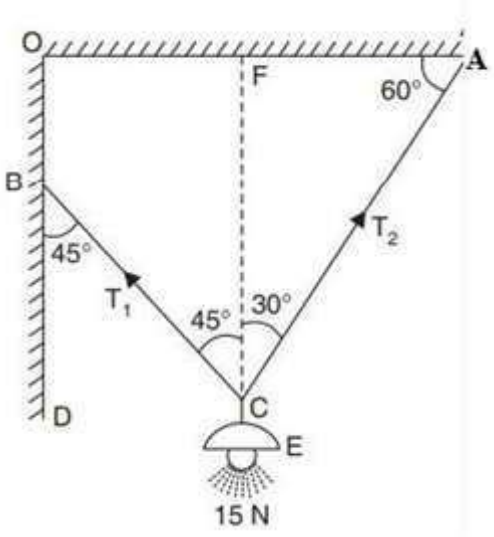
59. A thermos flask has a double-walled bottle and the space between the walls is evacuated to reduce the heat flow. The bottle surface is silver plated and the emissivity of each surface is 0.025. If the contents of the bottle are at 375 K, find the rate of heat loss from the thermos bottle to the ambient air at 300 K.
(A) 8.38 W
(B) 8.48 W
(C) 8.58 W
(D) 8.68 W

60. A body of weight 450 N is pulled up along an inclined plane having an inclination 30° to the horizontal at a steady speed. If the coefficient of friction between the body and the plane is 0.25 and force is applied parallel to the inclined plane. If the distance travelled by the body is 10 m along the plane, find the work done on the body?



(A) 3224.25 J
(B) 3324.25 J
(C) 3424.25 J
(D) 3524.25 J

61. An electric light fixture weighing 15 N hangs from a point C, by two strings AC and BC. AC is inclined at 60° to the horizontal and BC at 45° to the vertical as shown in the figure. Determine the forces in the strings AC and BC.



(A) 9.98 N, 7.76 N
(B) 10.98 N, 7.76 N
(C) 9.98 N, 5.76 N
(D) 10.98 N, 5.76 N

62. A gas turbine plant of 800 kW capacities takes the air at 1.01 bar and 15°C. The pressure ratio of the cycle is 6 and the maximum temperature is limited to 700°C. A regenerator of 75% effectiveness is added to the plant to increase the overall efficiency of the plant. The pressure drop in the combustion chamber is 0.15 bars as well as in the regenerator is also 0.15 bar. Assuming the isentropic efficiency of the compressor 80% and of the turbine 85%, determine the plant thermal efficiency. Neglect the mass of the fuel.
(A) 18.6%
(B) 19.6%
(C) 20.8%
(D) 17.8%

63. How knocking can be reduced in S.I. engines?
(A) By reducing the compression ratio.
(B) By reducing self-ignition temperature.
(C) By increasing wall temperature.
(D) By increasing inlet pressure.

64. A diesel engine has a compression ratio of 14 and cut-off takes place at 6% of the stroke. Find the air standard efficiency.
(A) 55%
(B) 60%
(C) 65%
(D) 70%

65. A cold storage is to be maintained at –5°C while the surroundings are at 35°C. The heat leakage from the surroundings into the cold storage is estimated to be 29 kW. The actual COP of the refrigeration plant used is one-third that of an ideal plant working between the same temperatures. Find the power required (in kW) to drive the plant.

(A) 10kW

(B) 15kW

(C) 13kW

(D) 17kW

66. The humidity ratio of atmospheric air at 28°C dry bulb temperature is 0.016 kg/kg of dry air. Approximate specific enthalpy of air is ……. kJ/kg of dry air.

(A) 66.68

(B) 67.68

(C) 68.98

(D) 69.98

67. For a two-dimensional potential function flow, the velocity potential is given by

$$\Phi = 4x(3y - 4)$$

Determine the velocity at point (2, 3). Determine also the stream function and its value at a point (2, 3)

(A) 31.24 units, 18 units

(B) 33.24 units, 18 units

(C) 31.24 units, 16 units

(D) 33.24 units, 16 units

68. A venturi meter is installed in a pipeline 30 cm in diameter. The throat pipe diameter ratio is 1/3. Water flows through the installation. The pressure in the pipeline is 137.7 kN/m^2 and the vacuum in the throat is 37.5 cm of mercury. If 4% of the differential head is lost between the gauges, find the flow in the pipeline.

(A) 1.124 m/s

(B) 2.134 m/s

(C) 3.164 m/s

(D) 4.154 m/s

69. In measuring the unit surface energy of mineral oil (specific gravity = 0.85) by the bubble method, a tube having an internal diameter of 1.5 mm is immersed to a depth of 12.5 mm in the oil. Air is forced through the tube forming a bubble at the lower end. What magnitude of unit surface energy will be indicated by a maximum bubble pressure intensity of 147.15 Pa?

(A) 14N/m

(B) 16N/m

(C) 18N/m

(D) 20N/m

70. A pipe of 15 cm diameter, 15 m long is connected to the bottom of a tank, 15 m long by 12 m wide. The original head over the open end of the pipe is 5 m. Find the time of emptying the tank, assuming the entrance to the pipe is sharp-edged. Assume f = 0.01

(A) 1.2 hours

(B) 1.8 hours

(C) 0.6 hours

(D) 2.4 hours

71. A model turbine constructed to a scale of 1/10 when tested under a head of 8 m at 400 r.p.m. gave an efficiency of 77 percent. Determine the ratio of powers developed by the prototype to model if the prototype works under a head of 100 m. What will be the efficiency of the prototype if the scale effect is considered?

(A) 4319.3, 72.9%

(B) 4419.3, 72.9%

(C) 4319.3, 76.9%

(D) 4419.3, 76.9%

72. A model of the spillway is made to test the flow. The discharge and the velocity of flow over the model were measured as 2.5 m^3/s and 1.5 m/s respectively. Find the discharge and the velocity over the prototype which is 50 times larger than its model.

(A) 43200 m^3/s, 8.62 m/s

(B) 43200 m^3/s, 10.62 m/s

(C) 44200 m^3/s, 8.62 m/s

(D) 44200 m^3/s, 10.62 m/s

73. Find Z_{max} for the function, Maximize

$$Z = 2x_1 + x_2$$

Subject to $x_1 + 2x_2 \leq 10$,

$x_1 + x_2 \leq 6$,

$x_1 - x_2 \leq 2$,

$x_1 - 2x_2 \leq 1$,

$x_1, \ x_2 \leq 0$

(A) 10

(B) 12

(C) 16

(D) 14

74. A newspaper boy buys papers for 5 paise each and sells them 6 paise each. He can not return unsold newspapers. Daily demand R for newspapers follows the distribution:

R:	10	11	12	13	14	15	16
P_R:	0.05	0.15	0.40	0.20	0.10	0.05	0.05

If each day's demand is independent of the previous day's, how many papers should be ordered each day?

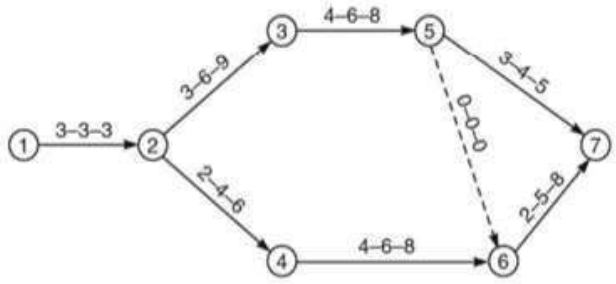
(A) 11

(B) 12

(C) 14

(D) 15

75. In the PERT network shown in the figure, the activity time estimates (in weeks) are given along the arrows. If the scheduled completion time is 23 weeks, calculate the latest possible occurrence times of the events. Calculate the slack for each event and identify the critical path. What is the probability that the project will be completed on the scheduled date?



(A) 94.62%

(B) 95.26%

(C) 96.62%

(D) 97.26%

76. A person repairing radios finds that the time spends on the radio sets has an exponential distribution with a mean of 20 minutes. If the radios are repaired in order in which they come in and their arrival is approximately Poisson with an average rate of 15 for 8 hour day. What is the repairman's expected idle time each day? How many jobs are ahead of the average set just brought in?
(A) 3 hours, 5/3
(B) 4 hours, 5/3
(C) 3 hours, 4/3
(D) 4 hours, 4/3

77. A HSS tool is used for turning operation. The tool life is 1 hour. When turning is carried at 30 m/min. The tool life will be reduced to 2.0 min if the cutting speed is doubled. Find the suitable speed in RPM for turning 300 mm diameter so that tool life is 30 min.
(A) 36.66 rpm
(B) 38.76 rpm
(C) 32.26 rpm
(D) 40.46 rpm

78. A cylindrical riser must be designed for a sand casting mold. The casting itself is a steel rectangular plate with dimensions 7.5 cm × 12.5 cm × 2.0 cm. Previous observations have indicated that the total solidification time (T_{TS}) for the casting = 1.6 min. The cylinder for the riser will have a diameter to height ratio = 1.0. Determine the diameter of the riser so that its T_{TS} = 2 min.
(A) 3.7 cm
(B) 4.7 cm
(C) 4.2 cm
(D) 5.1 cm

79. A turning operation is performed on a cylindrical work part whose diameter = 120 mm and length = 450 mm, cutting speed = 2.0 m/s, feed = 0.25mm/rev, and depth of cut = 2.2 mm. Determine the (a) cutting time and (b) MRR
(A) 4.35 min, 1100 mm^3/s
(B) 5.65 min, 1100 mm^3/s
(C) 4.35 min, 1300 mm^3/s
(D) 5.65 min, 1300 mm^3/s

80. A 300 mm wide strip with a thickness of 25 mm is fed.

A 300-mm-wide strip with a thickness of 25 mm is fed through a rolling mill with two powered rolls, each of radius = 250 mm. The work thickness is to be reduced to 22 mm in one pass at a roll speed of 50 rev/min. The work material has a flow curve defined by K = 275 MPa and n = 0.15, and the coefficient of friction between the rolls and the work is assumed to be 0.12. Determine if the friction is sufficient to permit the rolling operation to be accomplished. If it is, calculate the power consumed.
(A) 207201 W
(B) 204201 W
(C) 205501 W
(D) 206401 W

81. Determine the die and punch sizes for blanking a circular disc of 20 mm diameter from a sheet whose thickness is 1.5 mm.

Shear strength of sheet material = 294 MPa

(A) 20.17 mm, 19.83 mm

(B) 20 mm, 19.83 mm

(C) 20.17 mm, 20 mm

(D) 20 mm, 19.56 mm

82. A 12.5 mm diameter rod is to be reduced to 10 mm diameter by drawing in a single pass at a speed of 100 m/min. Assuming a semi-die angle of 5° and coefficient of friction between the die and steel rod as 0.15, calculate the power required in the drawing.

(A) 40.329 kW

(B) 46.529 kW

(C) 42.529 kW

(D) 44.329 kW

83. The area (in percentage) under standard normal distribution curve of random variable Z within limits from -3 to +3 is _____

(A) 68%

(B) 95%

(C) 99.7%

(D) 99.9%

84. The Voltage-Current characteristic for a dc source for arc welding is linear with open circuit voltage of 80 V and short-circuit current of 600 A. The maximum arc power of the source will be :

(A) 10 kW

(B) 12 kW

(C) 6 kW

(D) 16 kW

85. Point P (3, 1) is to be scaled by a factor of 2 and then rotated by 45° in the counter clockwise direction. Coordinates of the new point are :

(A) (4, 6)

(B) (2.828, 5.657)

(C) (6, 2)

(D) (5.657, –2.828)

86. The table of a CNC machine is driven by a lead screw which is rotated by a DC servomotor. A digital encoder that emits 1000 pulses per second is mounted on the lead screw as a feedback device. If the lead screw pitch is 6 mm and the motor rotates at 500 rpm, find basic length Units of the system and linear velocity of the table.

(A) 40 μm, 3 m/min

(B) 50 μm, 3 m/min

(C) 40 μm, 2 m/min

(D) 50 μm, 2 m/min

87. In a binary system of A and B. if a liquid of 35% A (65% B) is co-exists with a solid of 75% A (s5% B), for an overall composition of 40% A, the fraction of the liquid is given by

(A) 0.675
(B) 0.765
(C) 0.875
(D) 0.965

88. The turbine rotor of a ship has a mass of 2.2 tones and rotates at 1800 rpm clockwise when viewed from the aft (stern). The radius of gyration of the rotor is 320 mm. Determine the gyroscopic couple and its effect when ships turn right at a radius of 250 m with a speed of 25 km/h.

(A) 1180 Nm, lower the bow and raise the aft
(B) 1080 Nm, raise the bow and lower the aft
(C) 1080 Nm, lower the bow and raise the aft
(D) 1180 Nm, raise the bow and lower the aft

89. A shaft supported freely at the ends has a mass of 120 kg placed 250 mm from one end. Determine the frequency of the natural transverse vibrations if the length of the shaft is 700 mm, E = 200 GN/m^2 and the shaft diameter is 40 mm.

(A) 22.68 Hz
(B) 24.68 Hz
(C) 26.68 Hz
(D) 29.68 Hz

90. A single-cylinder vertical diesel engine has a mass of 400 kg and is mounted on a steel chassis frame. The static deflection owing to the weight of the chassis is 2.4 mm. The reciprocating masses of the engine amount to 18 kg and the stroke of the engine is 160 mm. A dashpot with a damping coefficient of 2 N/mm/s is also used to dampen the vibrations. In the steady-state of the vibrations, determine the amplitude of the vibration if the driving shaft rotates at 500 rpm.

(A) 0.72 mm
(B) 7.2 mm
(C) 0.072 mm
(D) 0.0072 mm

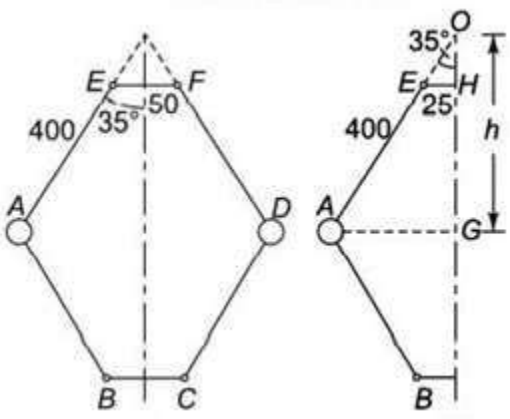
91. In a crank and slotted lever quick return motion mechanism, the distance between the fixed centers is 240 mm and the length of the driving crank is 120 mm, find the inclination of the slotted bar with the vertical in the extreme position and the time ratio of cutting strokes to return stroke.

(A) 30°, 2
(B) 45°, 2
(C) 30°, 3
(D) 45°, 3

92. A sample of 15 data is as follows :
17, 18, 17, 17, 13, 18, 5, 5, 6, 7, 8, 9, 20, 17, 3.
The mode of the data is

(A) 4
(B) 13
(C) 17
(D) 20

93. In an open-arm type governor as shown in figure, AE = 400 mm, EF = 50 mm and angle θ = 35°. Determine the percentage change in speed when θ decreases to 30°.



(A) 2.22 %

(B) 3.44 %

(C) 4.44 %

(D) 5.22 %

94. According to I.B.R., shearing resistance required to shear off the rivet per pitch length (in double shear) is (where n = Number of rivets per pitch length)

(A) $\frac{\pi}{4}$ d^2Tn

(B) $\frac{1.875\pi}{4}$ d^2Tn

(C) $\frac{2\pi}{4}$ d^2Tn

(D) $\frac{3\pi}{4}$ d^2Tn

95. Dynamic tooth load depends on

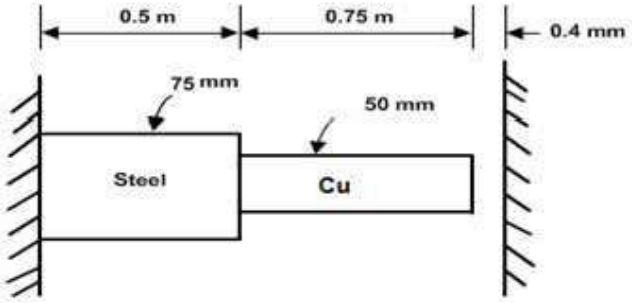
(A) Pitch line velocity

(B) Pressure angle

(C) Inaccuracy in tooth profile

(D) Misalignment of shafts

96. A rod consists of two parts that are made of steel and copper as shown in the figure below. The elastic modulus and coefficient of thermal expansion for steel are 200 GPa and 11.7×10^{-6} per °C respectively and for copper 70 GPa and 21.6×10^{-6} per °C respectively. If the temperature of the rod is raised by 50°C, determine the stress acting on the steel rod.



(A) +26.39 MPa

(B) +22.39 MPa

(C) –26.39 MPa

(D) –22.39 MPa

97. At a point in a crank shaft the stresses on two mutually perpendicular planes are 30 MPa (tensile) and 15 MPa (tensile). The

shear stress across these planes is 10 MPa. Find the magnitude of resultant stress on the plane making an angle 30° with the plane of first stress.

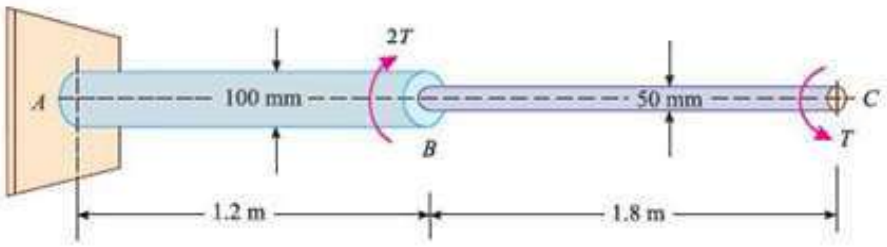
(A) 32.94 MPa

(B) 34.94 MPa

(C) 36.94 MPa

(D) 38.94 MPa

98. The stepped steel shaft shown in the figure is subjected to a torque (T) at the free end, and a torque (2T) in the opposite direction at the junction of the two sizes. What is the total angle of twist at the free end, if maximum shear stress in the shaft is limited to 70 MPa. Assume the modulus of rigidity to be 84 GPa.



(A) 0.0574 radian

(B) 0.0674 radian

(C) 0.0774 radian

(D) 0.0874 radian

99. A hollow alloy tube 4 m long with external and internal diameters of 40 mm and 25 mm respectively was found to extend 4.8 mm under a tensile load of 60 kN. Find the safe load for the tube with both ends pinned, taking a factor of safety as 5.

(A) 0.658 kN

(B) 0.758 kN

(C) 0.858 kN

(D) 0.958 kN

100. A cylindrical vessel 2 m long and 500 mm in diameter with 10 mm thick plates is subjected to an internal pressure of 3 MPa. Calculate the change in volume of the vessel. Take E = 200 GPa and Poisson's ratio = 0.3 for the vessel material.

(A) 185×10^3 mm^3

(B) 165×10^3 mm^3

(C) 185×10^2 mm^3

(D) 165×10^2 mm^3

ROUGH WORK

ROUGH WORK

Q.51. **0.915**

Q.52. **+2612 kJ**

Q.53. **143.4°C, 40% and 33.5%, 80 kJ**

Q.54. **0.05915 kJ/K**

Q.55. **112.51 kW**

Q.56. **47.08°C**

Q.57. **0.56, 2**

Q.58. **578W**

Q.59. **8.38 W**

Q.60. **3224.25 J**

Q.61. **10.98 N, 7.76 N**

Q.62. **19.6%**

Q.63. **By reducing the compression ratio**

Q.64. **60%**

Q.65. **13kW**

Q.66. **68.98**

Q.67. **31.24 units, 18 units**

Q.68. **2.134 m/s**

Q.69. **16N/m**

Q.70. **1.2 hours**

Q.71. **4419.3, 76.9%**

Q.72. **44200m^3/s, 10.62m/s**

Q.73. **10**

Q.74. **11**

Q.75. **97.26%**

Q.76. **3 hours, 5/3**

Q.77. **36.66 rpm**

Q.78. **4.7cm**

Q.79. **5.65 min, 1100 mm^3/s**

Q.80. **207201 W**

Q.81. **20mm, 19.83mm**

Q.82. **44.329 kW**

Q.83. **99.7%**

Q.84. **12 kW**

Q.85. **2.828, 5.657**

Q.86. **50µm, 3m/min**

Q.87. **0.875**

Q.88. **1180 Nm, lower the bow and raise the aft**

Q.89. **29.68 Hz**

Q.90 **7.2mm**

Q.91. **30^o, 2**

Q.92. **17**

Q.93. **3.44 %**

Q.94. $\frac{1.875\,\pi}{4} d^2 Tn$

Q.95. **Inaccuracy in tooth profile**

Q.96. **26.39MPa**

Q.97. **34.94MPa**

Q.98. **0.0574 radian**

Q.99. **0.858 kN**

Q.100. **185×10^3 mm^3**