Time: 2 hour 30 minutes   Max. Marks: 80

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Q1.	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks
1.	For the given material, if the stress concentration factor is 2 and notch sensitivity is 0.1, the fatigue stress concentration factor is:
Option A:	1
Option B:	1.2
Option C:	1.1
Option D:	0.9
2.	For Overhauling condition of screw (If ϕ= Friction angle, α = Helix angle)
Option A:	$\phi < \alpha$
Option B:	$\phi > \alpha$
Option C:	$\phi = \alpha$
Option D:	$\phi = 4\alpha$
3.	Yield point in fatigue loading as compared to static loading is
Option A:	Same
Option B:	Higher
Option C:	Lower
Option D:	Depends on other factors
4.	Factor of safety is the ratio of ------
Option A:	working stress and ultimate strength
Option B:	yield strength and endurance strength
Option C:	ultimate strength and yield strength
Option D:	yield strength and working stress
5.	A closely coiled helical spring having 10 complete turns is subjected to a tensile force of 0.2 kN, mean diameter of the coil is 12 cm and diameter of the wire is 10 mm. Determine deflection in the spring. Take G = 80 kN/mm^2
Option A:	34.56 mm
Option B:	52.32 mm
Option C:	25.65 mm
Option D:	46.12 mm
6.	Fatigue failure results due to fluctuating stresses when the stress magnitude is ----
Option A:	more than ultimate tensile strength
Option B:	more than yield strength but lower than ultimate tensile strength
Option C:	lower than yield strength
Option D:	none of the above
7.	Polygon effected is related to which of the following drive?
Option A:	Belt drive

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Option B:	Rope drive
Option C:	Chain drive
Option D:	Gear drive
8.	In thick cylinders, the tangential stress across the thickness of cylinder --------
Option A:	remains uniform throughout
Option B:	varies from internal pressure at the inner surface to zero at the outer surface
Option C:	varies from maximum value at the inner surface to minimum value at the outer surface
Option D:	varies from maximum value at the outer surface to minimum value at the inner surface
9.	Guest's theory of failure is applicable for following type of materials
Option A:	Brittle
Option B:	Ductile
Option C:	Elastic
Option D:	Plastic
10.	In which of the following machine flywheel is used?
Option A:	Drilling machine
Option B:	Surface grinder
Option C:	Milling machine
Option D:	Punch press

Q2.	Solve any Two Questions out of Three 10 marks each
A	Design cotter joint for 80kN, which varies from tension to compression. Select suitable material, factor of safety and draw neat sketch.
B	The shaft is supported in bearing 1m apart and transmits 10 KW at 1440 rpm. through a pulley 'A' of 300 mm diameter, mounted at 250 mm to the right of left hand bearing and another pulley B of 400 mm diameter which is mounted at 350 mm to the left of right hand bearing. The angle of lap is 180^0 and coefficient of friction between the belt & both the pulleys is 0.3. The pulley 'A' weighs 250 N and weight of pulley 'B' is 500 N. Select suitable material and design shaft. Take belt tensions at pulley 'A' as vertically downward and that on pulley 'B' as horizontal.
C	A Deep groove ball bearing of a machine shaft is subjected to an axial load of 5 KN and radial load of 12KN when operating on 1000 rpm. Consider the expected life of 10,000 hours with survival probability of 92%. Select suitable standard bearing.

Q3.	Solve any Two Questions out of Three 10 marks each
A	75 kW power is transmitted by multi-plate clutch at 3000 rpm. The plates run in oil and coefficient of friction is 0.07. Axial intensity of pressure is not to exceed 0.15 N/mm^2. Due to space limitation external radius is restricted to 125 mm. Assuming number of springs as 6. i. Design Input and Output Shaft. ii. Design Friction and pressure plates.
B	Design a flat belt to transmit 15KW power from an electric motor rotating at 1440rpm to a centrifugal pump. The reduction ratio is 1.8. The belt thickness is assumed to be 5mm and expected life to be 1800 hours, find the belt width. If pulley overhang is assumed to be equal to width of belt, find shaft diameter. Take service factor as 1.2.

C	The load on a 75×75 mm 360^0 hydrodynamic bearing is 12.5KN. Journal speed is 2000rpm and viscosity of oil is 10 Centipoise. Clearance ratio is $\frac{1}{1000}$. Calculate
	  1) Minimum oil film thickness
	  2) The coefficient of friction
	  3) Power loss in friction
	  4) The total flow rate

	5) Rise in temperature of bearing.

Q4.	
A	**Solve any Two 5 marks each**
i.	State the various types of keys used with shaft for torque transmission and describe their special features.
ii.	Explain aesthetic consideration in design with suitable examples.
iii.	What is the necessity of theories of failure? List different theories of failure.
B	**Solve any One** **10 marks each**
i.	A 70 mm diameter solid rod is to be welded to a flat plate by a fillet weld all around the circumference of the rod. Determine the size of weld required if a load of 12 KN is applied at the end of 250 mm overhang. The permissible shear stress for the material of the weld may be assumed as 95 N/mm^2.
ii.	A protected type flange coupling is required to transmit 20 kW at 300 rpm. Select suitable material for various parts and Design the coupling.

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Time: 2hour 30 minutes   Max. Marks: 80
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Q1.	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks
1.	Which intelligent agent works on partial observable environment?
Option A:	Model based agent
Option B:	Simple reflex agent
Option C:	Learning agent
Option D:	Goal based agent
2.	_____ is not the type of automation.
Option A:	Fixed Automation
Option B:	Programmable Automation
Option C:	Flexible Automation
Option D:	Independent Automation
3.	Which of the following statements are true for accumulators used in hydraulic systems? 1.accumulator stores fluid with pressure 2.accumulator stores fluid without any pressure 3.accumulator stores compressible liquid 4. spring is used as an external source to keep the fluid under hydraulic pressure
Option A:	1, 3 and 4
Option B:	2 and 3
Option C:	1 and 4
Option D:	2, 3 and 4
4.	_____ is not the part of Hydraulic System.
Option A:	Compressor
Option B:	Pump
Option C:	Motor
Option D:	Oil Sump
5.	The number of moveable joints in the base, the arm, and the end effectors of the robot determines_____.
Option A:	Flexibility
Option B:	payload capacity
Option C:	operational limits
Option D:	degrees of freedom
6.	The function of PLC is to_____.
Option A:	Control outputs based on logical decisions
Option B:	Control motor speed
Option C:	Control voltage change form high voltage to low voltage
Option D:	Amplify weak signals
7.	Initial & final position of piston rod is identified by_____
Option A:	Push button

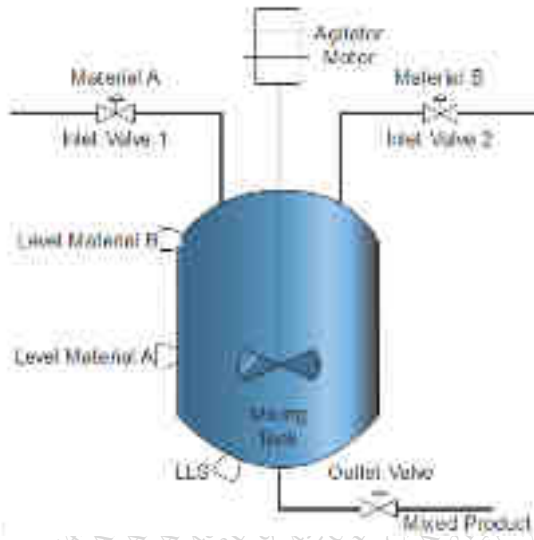|	
Option B:	DCV
Option C:	Hose pipes
Option D:	Limit Switch
8.	Which type of Machine learning use only labeled data for learning.
Option A:	Semi Supervised
Option B:	Unsupervised
Option C:	Reinforcement
Option D:	Supervised
9.	What is the DC range of solenoids in pneumatic systems?
Option A:	12 V and 24 V
Option B:	110 V and 220 V
Option C:	6V and 9V
Option D:	0 to 5 V
10.	Electric drive is preferred over Pneumatic and Hydraulic because of ___ .
Option A:	Less expensive
Option B:	Self-lubrication and cooling
Option C:	Positioning accuracy
Option D:	High strength

Subjective/Descriptive Questions

Q2	Solve any Four out of Six5 marks each
A	Explain Linear regression in detail with applications.
B	Draw and explain meter in and meter out circuit along with its significance in detail
C	Explain depth first search algorithm in short.
D	Write short note on FRL Unit
E	Draw and describe architecture of Goal Based agent.
F	Write short note on End effectors used in robots

Q3	Solve any Two Questions out of Three 10 marks each
A	Design electro pneumatic circuit for two cylinder operation withfollowing sequence using 5/2 both side solenoid operated valve asDCV. (AB)+ Delay A- B- (Where B- is 50% Slow) With user selection option single cycle & Multicycle operation.
B	Write detail note on Robot Configurations with respect to joints, applications, advantages and disadvantages. (any three)
C	Explain Supervised, Unsupervised and Reinforcement Learning with applications and examples in detail.

Q4.	
A	**Solve any Two** **5 marks each**
i.	State & explain K Means Clustering algorithm in detail.
ii.	Explain various levels of Automation.
iii.	Discuss concept of Natural language processing.
B	**Solve any One** **10 marks each**
i.	Draw PLC Ladder logic for following operation

	Material A and Material B are collected in a tank. These materials are mixed for a 5min. Mixed product is then drained out through Outlet valve. Level sensors are used to detect levels. Motor is used for mixing operation. Solenoid vales are used to control inlet and outlet operations.
ii.	Two double acting pneumatic cylinders A & B are selected for industrial application. Design PLC system to achieve the given output as per the following sequence specified (A+B+) (A-B-)

Program: Mechanical Engineering   **Curriculum Scheme:** REV- 2019 'C' Scheme

Examination: TE   **Semester:** VI

Course Code: MEC603   **Course Name:** HVAC&R

Time: 2 hour 30 Minutes   **Max. Marks:** 80

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N. B. :   1.   All questions are **compulsory.**

2.   Assume suitable data if required and state it clearly.

3.   Use of Steam Table, Psychrometric chart, P-H Chart is permitted.

Q1.	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks
1.	If a heat pump cycle operates between the condenser temperature of +27°C and evaporator temperature of -23°C, then the Carnot COP will be
Option A:	0.2
Option B:	1.2
Option C:	5.1
Option D:	6
2.	For summer air conditioner which of the following psychrometric process is applicable
Option A:	Cooling & Dehumidification
Option B:	Only Cooling
Option C:	Cooling & Humidification
Option D:	Only dehumidification
3.	In case of sensible cooling of air, the coil efficiency is given by
Option A:	BPF-1
Option B:	1-BPF
Option C:	1+ BPF
Option D:	1/BPF
4.	In load estimation, RSH = 39 and RLH = 13 then what will be value of RSHF
Option A:	0.36
Option B:	0.29
Option C:	0.47
Option D:	0.75
5.	Heat is absorbed by the refrigerant, during vapour compression refrigeration cycle in
Option A:	Compressor
Option B:	Condenser

Option C:	Evaporator
Option D:	Throttling valve
6.	The boiling point of ammonia is
Option A:	-100°C
Option B:	-50°C
Option C:	+33.3°C
Option D:	-33.3°C
7.	Atmospheric air with DBT of 28°c and WBT of 17°c is cooled to 15°c without changing its moisture content. Find original relative humidity, Final relative humidity and Final wet bulb temperature
Option A:	34% ,73% , 12°c repectively
Option B:	64% ,33% , 12°c repectively
Option C:	74% ,23% , 12°c repectively
Option D:	94% ,13% , 12°c repectively
8.	Equal friction method of designing air conditioning ducts
Option A:	Is ideal when the system is balanced
Option B:	Is ideal when the system is not balanced
Option C:	Is ideal only for return ducts
Option D:	Is ideal for none of the above
9.	When the moisture is added in to air at constant dry bulb temperature the process is known as
Option A:	Dehumidification
Option B:	Humidification
Option C:	Sensible cooling
Option D:	Sensible heating
10.	In HVACR industry refrigerant Air is designated as
Option A:	R-717
Option B:	R-744
Option C:	R-764
Option D:	R-729

Q2	Solve any Four out of Six Questions 5 marks each
A	Define i) Relative humidity ii) Ton of Refrigeration iii) Degree of Saturation, iv) Dew point temperature v) Coefficient of performance
B	What is the effective temperature? Which are the factors governing effective temperature?
C	What are the properties of good refrigerant? Compare the primary and secondary refrigerant with few examples.
D	Explain the various methods of duct design
E	Explain with suitable sketch working of Simple vapor absorption refrigeration system.
F	Explain the effect of changing evaporator pressure & condenser pressure on COP of VCR cycle with P-H Diagram.

Q3	Solve any Two Questions out of Three	10 marks each

A	The cockpit of a jet plane is to be cooled by a simple air refrigeration system. The data available is as follows.
	Cockpit cooling load =20 TR
	Speed of the plane = 1000km/hrs
	Ambient air temperature = -15°C
	Ram efficiency = 90%
	Pressure ratio in the main compressor =3
	Pressure drop in the heat exchanger =0.1 bar
	Isentropic efficiencies of main compressor and turbine = 80%
	Temperature of air entering the cooling Turbine = 30°C
	Pressure of the air leaving the cooling turbine = 1.06 bar
	Pressure in the cockpit = 1 bar
	If the cockpit is to be maintained at 25°C find
	    1) Stagnation temperature and pressure of air entering the main compressor
	    2) Mass flow rate of air to cockpit
	    3) Power required to drive the refrigerating system
	    4) C.O.P of the system	

B	Explain summer and winter air-conditioning processes with the help of psychrometric chart.	

C	A Simple NH_3 vapour compression system has compressor with piston displacement of 3 m^3/min, a condenser pressure of 12 bar and evaporator pressure of 2,5 bar. The liquid is sub-cooled to 20°Cby soldering the liquid line to suction line. The temperature of vapour leaving the cooling water is 6000KJ/hr and volumetric efficiency of compressor is 0.8. Use PH Chart. Find:
	    1) Capacity of the system
	    2) Indicated power
	    3) COP of the system
	    4) Draw P-H and T-S Diagram	

Q4.		
A	Solve any Two Questions out of Three	5 marks each
i.	Write a note on ICE plant	

ii.	Dry bulb temperature =30°c
	Wet bulb temperature = 20°c
	Barometer reading = 740 mm of Hg
	Using steam table. Determine
	    1. Partial pressure of water vapour
	    2. Relative humidity
	    3. Dew point temperature
	    4. Specific humidity
	    Vapour density	

iii.	Explain the use of heat pump for heating and cooling cycle with neat diagram.	
B	Solve any One Question out of Two	10 marks each
i.	The following data refers to the office of air conditioning plant having maximum seating capacity of 30 occupants. Outside design conditions: 36° CDBT and 27° CWBT Inside design conditions: 22° CDBT and 55% RH Solar heat gain: 8500 W Latent heat gain per occupant : 100 W	

	Sensible heat gain per occupant : 83W Lightening load: 2500 W Sensible heat load from other sources : 12000 W Infiltration load: 15 m3/min 1) Assuming 40% fresh air and 60 % of recirculated air passing through the evaporator coil and the by-pass factor of 0.12, Find dew point temperature of the coil and capacity of the plant.	
ii.	An air conditioning plant is required to supply 60 m³ of air per minute at a Dry bulb temperature of 21 deg C and 55% Relative humidity. The outside air is at dry bulb temperature of 28 deg C and 60% relative humidity. Determine the mass of water drained and capacity of the cooling coil. Assume the air conditioning plant first to dehumidify and then to cool the air	

	Choose the correct option for following questions. All the Questions carry equal marks
1.	Roll forging.....
Option A:	Causes a steadily applied pressure instead of impact force
Option B:	Is used to force the end of a heated bar into a desired shape
Option C:	Is a forging operation in which two halves of rotating die open and close rapidly while impacting the end of the heated tube or shell
Option D:	Is a forging method for reducing the diameter of a bar and in the process making it longer
2.	For obtaining a cup of diameter 25mm and 15mm height by drawing, the size of the round blank should be approximately
Option A:	42mm
Option B:	44mm
Option C:	46mm
Option D:	48mm
3.	Forging of a plain carbon steel is carried out...
Option A:	750°C
Option B:	900°C
Option C:	1100°C
Option D:	1300°C
4.	Coining is the operation of
Option A:	Cold forging
Option B:	Hot forging
Option C:	piercing
Option D:	Cold extrusion
5.	The process in which the product emerges in the same direction as the movement of the ram is
Option A:	Direct extrusion
Option B:	Indirect extrusion
Option C:	Hydrostatic extrusion
Option D:	Impact extrusion
6.	The seamless tubes in mass production are manufactured by the following process
Option A:	rolling
Option B:	extrusion
Option C:	spinning
Option D:	drawing
7.	In a rolling process, the state of stress of the material undergoing deformation is

Option A:	Pure compression
Option B:	Pure Shear
Option C:	Compression and Shear
Option D:	Tension and Shear

8.	A rolling mill is used to reduce the thickness of plate from 50 mm to 25 mm. The roll diameter is 700 mm and the coefficient of friction at the roll interface is 0.1. It is required that the draft in each pass must be the same. Assuming no front and back tensions, the minimum number of passes required in rolling are:
Option A:	16
Option B:	8
Option C:	4
Option D:	12

9.	A strip of thickness 40 mm is to be rolled to thickness of 20 mm using a two-high mill having rolls of diameter 200mm. Coefficient of friction and arc length in mm, respectively are
Option A:	0.45 and 38.84
Option B:	0.39 and 38.84
Option C:	0.39 and 44.72
Option D:	0.45 and 44.72

10.	Hot working operation is carried at
Option A:	Recrystallization temperature
Option B:	Above Recrystallization temperature
Option C:	Below Recrystallization temperature
Option D:	Above room temperature

Q2(20 Marks)	Solve any Four out of Six 5 marks each
A	Explain with neat figure different extrusion equipment used for Extrusion process.
B	Classify and discuss the extrusion processes.
C	Classify the different types of metal forming processes and explain in brief any one of them.
D	What is slip and how is the slip calculated for the process of rolling?
E	Draw Schematic and explain the different types of roller arrangements.
F	Classify different defects in extruded products.

Q3 (20 Marks)	Solve any Two Questions out of Three 10 marks each
A	A wire is drawn through a die with entrance angle = 15. Starting diameter is 2.5 mm and final diameter = 2 mm. The coefficient f friction at work die interface is 0.07. The metal has a strength coefficient K = 205 MPa. And strain hardening exponent n= 0.2. Determine the draw stress and draw force in this operation.
B	Differentiate elaborately between Hot and Cold working processes.
C	Define the forging process, state its applications, Draw the schematic stress flow patterns of forging

Q4(20 Marks)	Solve any Two Questions out of Three 10 marks each
A	Explain how seamless pipes are manufactured by extrusion process.
B	A 300 mm wide strip, 25 mm thick is fed through a rolling mill with two powered rolls each of radius 250 mm. The workpiece thickness is reduced to 22 mm in one pass at a roll speed of 50 rev/min. The work piece material has a flow curve defined by K = 275 MPa and n=0.15, and the co-efficient of friction is 0.12.Determine the roll force and power.
C	Discuss the mechanism of plastic deformation in any metal forming process.

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Q1.	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks
1.	High pressure boiler is the one in which pressure of steam generated is
Option A:	greater than 70 bar
Option B:	greater than 20 bar
Option C:	greater than 80 bar
Option D:	greater than 40 but less than 80 bar
2.	The ratio of heat actually used in producing the steam to the heat liberated in the furnace is called......
Option A:	Steam efficiency
Option B:	Boiler efficiency
Option C:	Evaporation capacity of a boiler
Option D:	None of the above
3.	In a centrifugal pump the liquid enters the pump ....
Option A:	At the top
Option B:	At the bottom
Option C:	At the center
Option D:	From sides
4.	Indicator diagram of a reciprocating pump is a graph between....
Option A:	Floor vs swept volume
Option B:	Pressure in cylinder vs stroke length
Option C:	Flow vs speed
Option D:	Pressure vs speed
5.	In an impulse steam turbine ____
Option A:	The steam is expanded in nozzles only and there is a pressure drop and heat drop
Option B:	The steam is expanded both in fixed and moving blades continuously
Option C:	The steam is expanded in moving blades only
Option D:	The pressure and temperature of steam remains constant
6.	In a reaction steam turbine _____.
Option A:	The steam is allowed to expand in the nozzle, where it gives a high velocity before it enters the moving blades
Option B:	The expansion of steam takes place partly in the fixed blades and partly in the moving blades
Option C:	The steam is expanded from a high pressure to a condenser pressure in one or more nozzles
Option D:	The pressure and temperature of steam remains constant
7.	Reciprocating Compression efficiency is compared against
Option A:	Adiabatic compression
Option B:	Both isothermal and adiabatic compression
Option C:	Isentropic compression

Option D:	Isothermal compression
8.	Volumetric efficiency of a reciprocating compressor
Option A:	Increases with increase in clearance volume
Option B:	Decreases with increase in clearance volume
Option C:	Is not dependent upon clearance volume
Option D:	Can't predict
9.	Pelton turbine is _____
Option A:	Tangential flow
Option B:	Radial flow
Option C:	Mixed flow
Option D:	Axial flow
10.	In a two-stage gas turbine plant, with intercooling and reheating_____.
Option A:	Both work ratio and thermal efficiency improve
Option B:	Work ratio improves but thermal efficiency decreases
Option C:	Thermal efficiency improves but work ratio decreases
Option D:	Both work ratio and thermal efficiency decreases

Q 2	Solve any Two Questions out of Three 10 marks each
A	Draw a neat sketch of various components of the centrifugal compressor and show thevariation of pressure and velocity of air being compressed.
B	The air in a gas turbine plant is taken in at low pressure at 293 K and 1.05 bar and aftercompressionitispassedthroughintercooler, whereitstemperatureisreducedto300K. The cooled air is further compressed in high pressure compressor and then passed in thecombustion chamber, where its temperature is increased to 750^0C by burning the fuel. The combustion products expand in high pressure turbine which runs the compressor andfurther expansion is continued in low pressure turbine which runs the alternator. The gascoming out from low pressure turbine are used for heating the incoming air from highpressurecompressorandthen expanded toatmosphere. Pressure ratio of each compressor = 2, η_{iso} (each compressor stage) = 82%, η_{iso} (eachturbinestage) =82%, effectivenessofheatexchanger=0.72, airflowrate=16kg/s,C.V.offuel=42,000kJ/kg,C_v(air)=1.0kJ/kgK,C_p(gas)=1.15kJ/kgK,γ_{air}=1.4, γ_{gas}=1.33. Neglecting massof fuel, Calculate: (i) Power output, (ii) Thermal efficiency, (iii)Specificfuelconsumption.
C	The impeller of centrifugal pump is of 320 mm diameter and 55 mm with at the periphery and has blades whose tip angle inclinedbackward 60° from the radius. The pump delivers 18 m^3/min of water and impeller rotates at 1000 rpm. Assuming that the pump is designed to admit radially. Calculate 1. speed and direction of water as it leaves the impeller 2. torque exerted by the impeller on water 3. shaft power required 4. lift of the pump

Q 3	Solve any Two Questions out of Three 10 marks each
A	Makealist of anyfive boiler mountings andwritetheir function and location in boiler cell, with sketch diagram.
B	Followingobservation weremadeduringatest onsteam boiler. Boilerpressure=10bar, calorificvalueoffuelused=33000kJ/kg,feedwatertemperatureenteringtheeconomizer=25^{0}C,andl

	eaving the economizer = 80^0C, condition of steam leaving the superheater = 250^0C, steam condition leaving the boiler = 0.95, amount of water evaporated = 6000 kg/hr, amount of fuel burnt = 600 kg/hr. Find the equivalent evaporation with and without superheater, boiler efficiency, and the percentage of heat utilized in the boiler, economizer and the superheater.
C	Steam with a velocity of 400 m/s relative to the moving blades enters an impulse turbine at an angle of 30°. The blade velocity is 20 m/s. The work developed in the blades is estimated to be 165.54 kW/kg. Assuming the blades to be symmetrical in shape, determine the blade efficiency and blade velocity coefficient.

Q4	Solve any Two Questions out of Three 10 marks each	
A	A boiler produces 200 kg of steam per hour at 10 bar and 0.95 dry. Feed water is heated by an economizer to a temperature of 110^0C. 225 kg of coal of calorific value of 30100 kJ/kg is fired per hour. If 10 % of coal remain unburnt, find the thermal efficiency of boiler and boiler and grate combined.	
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 15^0 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 m^3/s (iii) The force exerted by a jet on the buckets.	
C	Derive the expression for optimum pressure ratio for maximum specific output in actual simple gas turbine cycle.	