Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)
Munshi Nagar, Andheri (W) Mumbai – 400058

Re-Examinations, June 2019.

Program: **B.Tech. (Mechanical Engineering)** Duration: **Three Hour**

Course Code: **PCC BTM 506** Maximum Points :**100**

Course Name: **NUMERICAL METHOD** Semester : **V**

Notes

- Answer any FIVE questions.
- Make appropriate assumption if required. Answer to all sub-questions must be grouped together.
- Data shown under columns CO, BL and PI are only for academic evaluation.
  (CO: Course Outcome, BL: Blooms Taxonomy, PI: Performance Indicator)

		Points	*CO*	*BL*	*PI*
1.	**A.** Differentiate between initial value and boundary value problem. Explain the logic of shooting method and discuss its execution methodology.	**10**	*1*	*1,2*	
	B. A solid of revolution is formed by rotating about the x-axis, the area between the x-axis, the line x=0 and x=1, and a curve through the points with the following coordinates:				

x	0	0.25	0.50	0.75	1.00
y	1.000	0.9896	0.9589	0.9089	0.8415

10 *2* *3*

Using 1/3 Simpson formula, estimate the volume of the solid formed,

$V = \pi \int_0^1 y^2 dx$, giving the answer to three decimal places.

2	**A.** Answer any **four (04)** of the following: (i) Distinguish between lumped and distributed approach of mathematical modeling. Give one example for each approach. (ii) Define terms: (a) accuracy, (b) precision, and (c) truncation error. (iii) Discuss about the convergence rate of Jacobi method or Gauss-Seidel method. (iv) Write the method of Regula-Falsi to obtain a root of f(x) = 0. Discuss its limitations. (v) Using Taylor series suggest a second order accurate representation of dy/dx and d^2y/dx^2	**10**	*1,2*	*2*	
	B. Consider a composite fin of carbon steel of circular cross section. It is coated with a thin dielectric layer for corrosion protection. The dielectric layer serves as a protective shield. The composite fin is immersed in a brine solution whose velocity is such that the surface heat transfer coefficient establish as 'h'. Develop a mathematical model to predict temperature distribution along fin length. List all assumption to model the problem.	**10**	*2,3*	*3,4*	
3.	**A.** Name any four numerical methods to solve a non-linear algebraic equation. Explain their approach to obtain solution. Also discuss their limitations.	**10**	*1*	*1,2*	
	B. Use the Gauss-Seidel method without relaxation to solve the following system to a tolerance of ε= 5 5%. If necessary, rearrange the equations to		*2*	*3*	

achieve convergence. **10**

$$-3x_1 + x_2 + 12x_3 = 50$$
$$6x_1 - x_2 - x_3 = 3$$
$$6x_1 + 9x_2 + x_3 = 40$$

4. **A.** State the features of spline interpolation? Explain procedure for its execution. **10** *1* *1,2*
B. An outcome of experimental investigation is depicted in following table in the form of input variable and output f(x). **10** *2,3* *5*

x	1	3	4	5	7	10
f(x)	3	31	69	131	351	1011

(a) Construct Newton's forward divided difference table and develop interpolating polynomial.
(a) Predict maximum order of polynomial through the table of divided difference.
(b) Compare the values obtained from two quadratic polynomial using any two different data set of three, for f(4.5), f(8) and the second derivative of f(x) at x=3.2.

5. **A.** Name a numerical method to solve a boundary value problem and explain procedure for calculation. **10** *2,3* *1,5*

B. A copper sphere of diameter 5 cm is initially at temperature 200°C. It cools in air by convection and radiation. The temperature T of the sphere is governed by the energy equation **10** *2,3* *3*

$$\rho CV\frac{dT}{dt} = -\left[\varepsilon\sigma(T^4 - T_a^4) + h(T - T_a)\right]A$$

All terms carries their usual meaning.
Evaluate the temperature variation with time using the RK-II method and determine the time needed for the temperature to drop below 100°C.

6. **A.** Derive the Simpson's 1/3 rule. **10** *1* *1*
B. Construct Newton's divided difference polynomial of second order using following data. Also comment on nature of possible polynomial based on difference table. **10** *2,3* *4*

x	1	0.2	0.4	0.6	0.8	1	1.2
f(x)	0	0.0016	0.0256	0.1296	0.4096	1	2.0736

7. **A.** Explain the concept of curve fitting. What is the procedure of least square method. **10** *1* *1*
B. In a manufacturing process, a spherical piece of metal is subjected to radiative-convective heat transfer, resulting in the energy balance equation, **10** *2,3* *4,5*

$$0.6 \times 5.67 \times 10^{-8}\left[(850)^4 - T^4\right] = 40 \times (T - 350)$$

Consider the surface emissivity as 0.6, temperature of the radiating source 850 K, Stefan-Boltzman constant 5.67×10^{-8} W/(m^{2}K^4), the ambient fluid temperature 350 K and the convective heat transfer coeffcient 40 W/(m^2 ·K). Find the temperature T by applying the **SECANT** method.

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June 2019 Re--Examinations

Program: T.Y.B. Tech. (Mechanical Engineering) | **Duration: 03 Hrs**

Course Code: PCC-BTM505 | **Maximum Points: 100**

Course Name: Hydraulic Machinery | **Semester: V**

Notes:
1. Question number 1 is compulsory; solve any 4 questions from question 2 to 7.
2. If necessary assume suitable data with justification
3. Draw neat labeled sketches wherever required.

Q.No.	Questions	Points	CO	BL	PI
1	With neat sketches write short note on (i) Vane Pump (ii) Axial flow Reaction Turbine (iii) Cavitations in Turbine and methods to avoid it (iv) Net Positive Suction Head	20	1,2	3	1.1.3
2 (a)	A pump has the following characteristics when running at 1425 rpm Q (m^3/s): 0, 0.225, 0.335, 0.425, 0.545, 0.65, 0.75 H (m): 20, 17, 15, 13, 10, 7, 3 At zero head the discharge is 0.8 m^3/s. This pump is used in resistive system where the static lift is -5 m (Note: This is negative static head). Further, in this system, discharge obtained by connecting two such identical pumps in series is same when operated with single standalone in system. Find discharge obtained when pump is not used in system. Further find the discharge obtained by single pump when connected parallel with other identical pump.	10	3	4	2.8.2
2 (b)	Explain negative slip in reciprocating pump with the help of indicator diagram.	05	1	1	1.6.1
2 (c)	With neat sketch explain salient features of Pelton wheel buckets and working of impulse turbine	05	4	2	1.5.1
3 (a)	A centrifugal pump has a suction pipeline of 12.5 cm diameter and 10 m length. The static suction lift is 2m. Friction factor for pipe is 0.02. The pump delivers oil of specific gravity 0.8, the vapour pressure for oil at ambient temperature being 0.015 kg/cm^2 absolute. The NPSHR characteristic of the pump is given by the equation $15Q+65Q^2$ where NPSHR is in meters of water column absolute and Q is in m^3/s. If the ambient pressure is 1 bar (abs) determine the maximum discharge the	10	3	5	2.6.4

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	pump can handle without cavitating.				
3(b)	A Kaplan turbine runner is to be designed to develop 7357.5 KW shaft power. The net head available is 5.50 m. Assume that the speed ratio is 2.09 and flow ratio is 0.68, and the overall efficiency is 60%. The diameter of the boss is 1/3rd of the diameter of the runner. Find the diameter of the runner, its speed and its specific speed.	10	3	3	2.7.2
4(a)	A single acting reciprocating pump is to raise a liquid of density 1200 kg per cubic metre through a vertical height of 11.5 metres, from 2.5 metres below pump axis to 9 metres above it. The plunger, which moves with S.H.M. has diameter 125 mm, and stroke 225 mm. The suction and delivery pipes are 75 mm diameter and 3.5.metres and 13.5 metres long respectively. There is a large air vessel placed on the delivery pipe near the pump axis. But there is no air vessel on the suction pipe. If separation takes place at 8.829 N/cm^2 below atmospheric pressure, find: (1) maximum speed, with which the pump can run without separation taking place, and (2) power required to drive the pump, if f=0.08. Neglect slip for pump. Consider maximum speed as operating condition.	10	2	4	2.6.4
4(b)	Write short note on governing of reaction turbines with neat sketches	10	1	1	1.5.1
5(a)	Write short note on (i) Selection of Turbines (ii) Detailed classification of Turbines and Pumps	10	4	3	2.6.4
5(b)	Manometric head discharge characteristics of a centrifugal pump is given by the equation: $Hm=20+15Q-600Q^2$ Where Hm is in m and Q is in m^3/s. System curve for a typical installation is estimated as $10+900Q^2$ (Q is in m^3/s), where 10 is static head in m. If the NPSHR characteristics of the pump is given by equation: $NPSHR=20Q+60Q^2$ where Q is in m^3/s, evaluate how high the pump can be safely installed above the sump if suction pipe diameter is 15 cm, pipe length on suction side is 1.5 times static suction lift and 'f' for the pipe is 0.016. Evaluate the cavitation parameter 'σ' if pump runs at 1440 rpm and operates at duty point. Calculate the specific speed and suction specific speed. Take atmospheric and vapour pressure being 10.3 and 2.5 mWc respectively.	10	4	5	2.6.4
6(a)	The three jet Pelton turbine is required to generate 10000 KW	**10**	3	4	3.7.1

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	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%, Cv=0.98 and speed ratio=0.46, then find: (i) the diameter of the jet (ii) total flow in m^3/s and (iii) the force exerted by a jet on the buckets. If the jet ratio is not to be less than 10, find the speed of the wheel for a frequency of 50 Hz and the corresponding wheel diameter.				
6(b)	A hydraulic turbine is to develop 1015 KW when running at 120 rpm under a net head of 12 m. Work out the maximum flow rate and specific speed for the turbine if the overall efficiency at the best operating point is 92%. In order to predict its performance, a 1:10 scale model is tested under a head of 7.2 m. What would be the speed, power output and water consumption of the model if it runs under the conditions similar to the prototype?	10	3	3	2.7.2
7(a)	An inward flow reaction turbine has external and internal diameters as 1.08 m and 0.54 m. The turbine is running at 200 rpm. The width of the turbine at inlet is 240 mm and velocity of flow through the runner is constant and is equal to 2.16 m/s. The guide blade makes an angle of 10^0 to the tangent of the wheel at inlet and discharge at the outlet of the turbine is radial. Draw rough nature of inlet and outlet velocity triangles and determine (i) The absolute velocity of water at inlet (ii) The velocity of whirl at inlet (iii) The relative velocity at inlet (iv) The runner blade angles (v) width of runner at outlet (vi) weight of water flowing through the runner per second (vii) Head at inlet of the turbine (viii) Runner power (ix) Hydraulic efficiency of the turbine.	10	2	4	3.7.1
7(b)	A three-stage centrifugal pump has impeller 400 mm in diameter and 20 mm wide. The vane angle at outlet is 45^0 and the area occupied by the vane thickness may be assumed 8% of the total area. If the pump delivers 3.6 m^3/min of water when running at 920 rpm, determine (i) Power of the pump (ii) Manometric head and (iii) specific speed. Assume mechanical efficiency as 88% and manometric efficiency as 77%.	10	3	3	2.7.2

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ODD SEMJUNE 2019RE-EXAMINATIONS

Program: B. Tech (Mechanical) | **Duration: 3 Hours**

Course Code: PCC-BTM504 | **Maximum Points: 100**

Course Name: Thermal Systems | **Semester: V**

1. **Notes:** Question number 1 is compulsory; answer any **Four** questions out of remaining **Six** questions.
2. Use of steam table is permitted.
3. Assume suitable data and justify the same.

Q.No.	Questions	Points	CO	BL	PI
1(a)	Discuss in detail multi-staging of reciprocating air compressor.	5	1	1	2.3.1
1(b)	Differentiate between high and low pressure boiler	5	1	1	2.3.1
1(c)	Differentiate between impulse and reaction turbine	5	3	1	2.3.1
1(d)	Enlist various applications of gas turbine	5	3	1	2.3.1
2(a)	Prove that the condition for minimum work per kg of air delivered by two stage compressor when inter-cooling is perfect is given by: $P_2 = \sqrt{P_1 P_3}$	8	1	2	2.3.2
2(b)	A two stage double acting air compressor operating at 250 rpm takes air in at 1.013 bar and 27^0 C. The diameter and stroke of L.P cylinder are 37 cm and 40 cm respectively. The stroke of H.P cylinder is same as L.P. cylinder and clearance of both the cylinder is 5% of the stroke. The L.P. cylinder discharges air at a pressure of 4.052 bar. The air passes through the intercooler so that it enters the H.P. cylinder at 27^0 C and 3.85 bar. Finally, the air is discharged from the compressor at 15.4 bar. The compression and re-expansion in both the cylinder	12	2	4	2.4.1

	follows the same law $pv^{1.3}$ =Constant. Determine (i) Brake power required to run the compressor if mechanical efficiency is 85 % (ii) The diameter of H.P. cylinder (iii) Heat rejected in intercooler. Take C_p = 1 kJ/kg-K and R = 287 J/kg-K for air.				
3(a)	Derive equation for critical pressure ratio of a nozzle and prove that for maximum discharge pressure ratio is given by: $\frac{P_2}{P_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$	8	1	2	2.3.1
3(b)	A steam turbine develops 160 kW with a consumption of 19.4 kg/kWh. The pressure and temperature of the steam entering the nozzle are 12 bar and 220°C. The steam leaves the nozzles at 1.2 bar. If the diameter of the nozzle at throat is 7 mm, find the number of nozzles required. If 8 % of the total enthalpy drop is used up in frictional reheating in the diverging part of the nozzle, determine the diameter at the exit of nozzle and quality of steam leaving the nozzle.	12	4	4	2.4.1
4(a)	Prove that condition for maximum blade efficiency of a reaction turbine is given by relation: $\eta_b = \frac{2\cos^2\alpha}{1+\cos^2\alpha}$	08	3	2	2.3.1
4(b)	Saturated steam at 10 bar is supplied to a single stage steam turbine through a convergent-divergent steam nozzle. The nozzle angle is 20° and the mean blade speed is 440 m/sec. The steam pressure leaving the nozzle is 1 bar. Find (i) the best angle if the blades are equiangular and (ii) the maximum power developed by the turbine if the numbers of nozzles used are 6 and area at the throat of each nozzle is 0.5 cm^2. Assume a nozzle efficiency of 90 % and blade friction coefficient of 0.85.	12	4	4	2.4.1

5(a)	Explain with neat sketch working of root blower and vane-type blower.	8	1	1	2.3.1
5(b)	Explain why boiler accessories are used in the boiler and explain in detail function of economiser and air preheater with neat sketch.	12	3	1	2.3.1
6(a)	Explain evaporative condenser with neat sketch.	10	3	1	2.3.1
6(b)	Explain advantages and limitations of rotary verses reciprocating compressors and axial verses centrifugal compressors.	10	3	1	2.3.1
7(a)	What are the methods of improving efficiency of open cycle gas turbine? Explain open cycle gas turbine with reheating.	6	3	1	2.3.1
7(b)	In a gas turbine power plant the compressed air goes to combustion chamber through regenerator. This air is then expanded over the turbine and passed through regenerator. The following data is given: Isentropic efficiency of compressor = 0.83, Isentropic efficiency of turbine = 0.85, Mechanical transmission efficiency = 0.99, Combustion efficiency = 0.98, Heat Exchanger effectiveness =0.80, Pressure ratio = 4.0, Maximum cycle temperature = 11000 K, Ambient conditions = 1 bar and 288 K. Calorific value of fuel = 42 000 kJ/kg. Calculate specific work output, specific fuel consumption and cycle efficiency. Neglect mass of fuel while calculating heat taken by gases. Take C_p = 1.005 kJ/ kg-K , γ = 1.4 during compression and C_p = 1.147 kJ/kg-K, γ = 1.33 during combustion and expansion.	14	4	4	2.4.1