B.E. (Mechanical Engineering / Power Engineering) Sixth Semester (C.B.S.)

Energy Conversion-I

P. Pages : 3 **NRT/KS/19/3479/3505**

Time : Three Hours * 0 6 1 5 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Use of non programmable calculator is permitted.
11. Use of steam tables & Mollier chart is permitted.

1. a) State the unique features of high pressure boilers, and desirable qualities of a good boiler. **6**

b) Explain construction and working of Cochran boiler with neat sketch. **7**

OR

2. a) Define boiler mountings & accessories. Enlist the various boiler mountings and accessories. **6**

b) Explain construction and working of Economizer with neat sketch. **7**

3. a) Calculate the mass of flue gases flowing through the chimney when the draught produced is equal to 1.9 cm of water. Temperature of flue gases is 290ºC and ambient temperature is 20ºC.The flue gases formed per kg of fuel burnt are 23 kg. Neglect the losses and take the diameter of chimney as 1.8 m. **6**

b) A 40m high chimney is discharging flue gases at 623K, when the ambient temperature is 303 K. The quantity of air supplied is 13 kg of air per kg of fuel burnt. Determine **7**

i) Draught produced in mm of water column.
ii) Equivalent draught in metres of hot gas column.
iii) Efficiency of the chimney, if the minimum temperature of artificial draught is 423 K. The mean specific heat of flue gas is 1.005 kJ/kg. K.
iv) Temperature of chimney gases for maximum discharge in the given time and what would be the draught produced correspondingly.

OR

4. The following particulars were recorded during a boiler trial. **14**
Pressure of steam = 11 bar, Mass of feed
Water = 4600 kg/h, Temperature of feed
Water = 75º C, Dryness fraction of steam = 0.96, coal used = 490 kg/h,
calorific value of coal = 35700 kJ/kg, moisture in coal = 4% by mass, mass of dry flue gases = 18.57 kg/kg of coal, temperature of flue gases = 300ºC, Boiler house temperature = 16ºC, specific heat of flue gases = 0.97 kJ/kg K. Draw up heat balance sheet for the boiler per kg of coal.

5. Write short notes on **any two.** **14**

i) Coal Preparation Plant.
ii) Ash handling system.
iii) Bubbling fluidized bed boiler.

OR

6. Write short notes on **any two.** **14**

i) Need of cogeneration & its types.
ii) Steam turbine and gas turbine cogeneration system.
iii) Topping cycle & bottoming cycle.

7. a) The nozzles of a Delaval steam turbine are supplied with dry saturated steam at a pressure of 9 bar. The pressure at the outlet is 1 bar. The turbine has two nozzles with a throat diameter of 2.5mm. Assuming nozzle efficiency as 90% and that of turbine rotor 35%, find the quality of steam used per hour and the power developed. **7**

b) State the assumptions used in analysis of steam nozzles & derive the expression for velocity of steam flowing through nozzle. **6**

OR

8. a) Explain metastable flow of steam in a nozzle with its effects. **5**

b) Steam at a pressure of 11 bar and dryness fraction of 0.98 is discharged through convergent divergent nozzle to back pressure of 0.1. The mass flow rate of steam is 12 kg/kWh. if power developed is 250 kW. Determine **8**

i) Pressure at the throat.
ii) Number of nozzles required and dimensions of nozzle if each nozzle has throat of rectangular cross section of 5mm $\times$ 10mm. If 10% of overall isentropic enthalpy drop reheats the steam by friction in divergent portion.

9. a) Explain with neat sketch velocity diagram for a single stage impulse turbine. **3**

b) A single stage impulse turbine is supplied with steam at 4 bar and 160ºC. and it is exhausted at a condenser pressure of 0.15 bar at the rate of 60 kg/min. The steam expands in a nozzle with an efficiency of 90%. The blade speed is 250 m/s and the nozzles are inclined at 20º to the plane of wheel. The blade angle at the exit of the moving blade is 30º. Neglecting friction losses in the moving blade, determine: **10**

i) Steam jet velocity. ii) Power developed.
iii) Blade efficiency and iv) Stage efficiency.

OR

10. a) Define the term 'degree of reaction' as applied to a steam turbine. Show that for Parson's reaction turbine the degree of reaction is 50% **6**

b) A stage of a turbine with parsons blading delivers dry saturated steam at 2.7 bar from the fixed blades at 90 m/s. The mean blade height is 40 mm, and the moving blade exit angle is 20º. The axial velocity of steam is ¾ of the blade velocity at the mean radius. Steam is supplied to the stage at the rate 9000 kg/h the effect of the blade tip thickness on the annulus area can be neglected. **7**

Calculate:

i) The wheel speed in r. p. m
ii) The diagram power.
iii) The diagram efficiency.

11. a) Define, vacuum efficiency and condenser efficiency. **4**

b) The following observations were taken during a test on a surface condenser: **10**
Vacuum in condenser = 71.5 cm of Hg,
Barometer reading = 76.5 cm of Hg,
Temperature in condenser = 32ºC,
Hot well temperature = 30ºC,
cooling water circulated = 48000 $\frac{kg}{hr}$,
Inlet and outlet temperature of cooling water = 14ºC & 28ºC,
Condensate collected = 1500 kg/hr.
Find
a) The mass of air in kg/m^3 of condenser volume.
b) The dryness fraction of steam entering the condenser.
c) The vacuum efficiency.
d) Degreed under cooling.
e) Condenser efficiency.

OR

12. a) Differenciate between induced draught and forced drought cooling tower. **4**

b) The air leakage into a surface condenser operating with a steam turbine is estimated as 84 kg|h. The vacuum near the inlet of air. **10**
Pump is 700 mm of Hg, when barometer reads 760 mm of Hg. The temperature at inlet of vacuum pump is 20ºC. Calculate:
i) The minimum capacity of air pump in m^3/h.
ii) The dimensions of the reciprocating air pump to remove the air if it runs at 200 r. p. m. Take L/D ratio = 1.5 and volumetric efficiency = 100% and
iii) The mass of vapour extracted per minute.

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B.E.(Mechanical Engineering) Sixth Semester (C.B.S.)

Control System Engineering

P. Pages : 3 **NRT/KS/19/3480**

Time : Three Hours * 0 6 1 3 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
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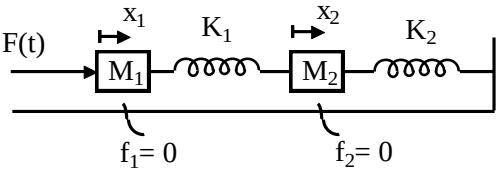
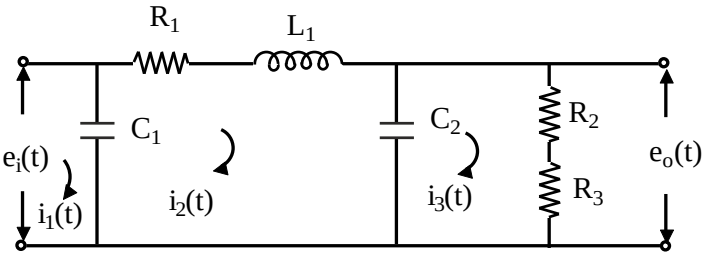
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

1. a) Find $\frac{X_2(s)}{F(s)}$ **7**



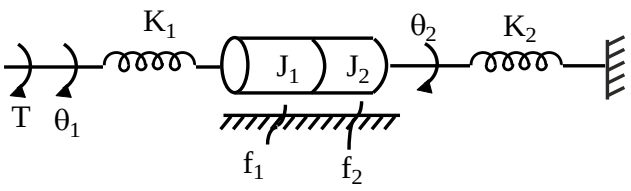
b) Find T. F $\frac{E_0(s)}{E_i(s)}$ **7**



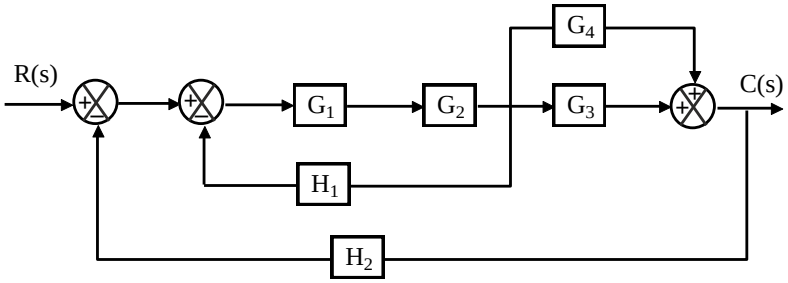
OR

2. a) Explain open loop and close loop system with advantages and disadvantages. **6**

b) Find T. F $\frac{\theta_2(s)}{T(s)}$ and $\frac{\theta_1(s)}{T(s)}$ **8**



3. a) Find $\frac{C(s)}{R(s)}$ by using Block Reduction Technique. **6**



b) Convert the given equation into signal flow graph and find its transfer function. **7**

$Y_2 = G_1 Y_1 + G_3 Y_3$

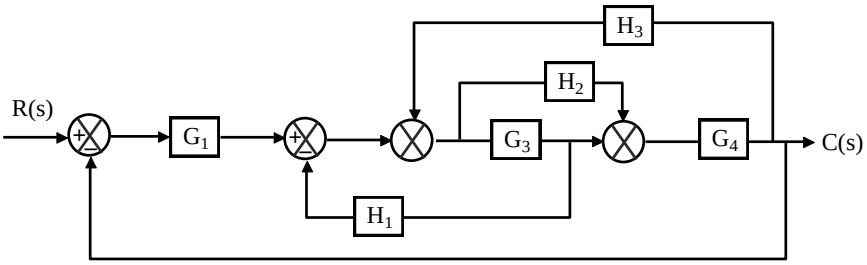
$Y_3 = G_4 Y_1 + G_2 Y_2 + G_5 Y_3$

$Y_4 = G_6 Y_2 + G_7 Y_3$

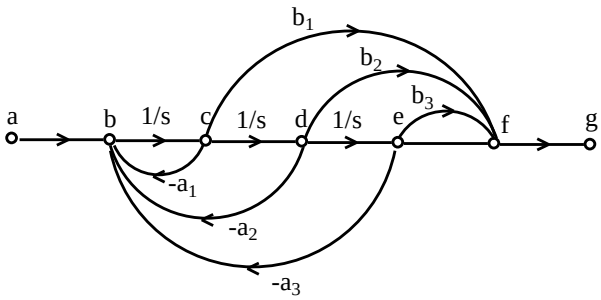
where Y_4 is output and Y_1 is input

OR

4. a) Obtain $\frac{C(s)}{R(s)}$ using block reduction technique. **6**



b) Find T. F of following S.F.G **7**



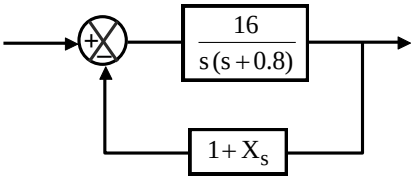
5. a) Derive the transfer function of field controlled DC motor. **6**

b) Derive an expression for unit ramp response of first order system. **7**

OR

6. a) System O/P & I/P equation is given by $\ddot{y} + 6\dot{y} + 16y = 16x$. Determine the transfer function and the response for step of 2.5 units. Also find the time domain specifications. **7**

b) Find the value of x such that $\xi = 0.5$ **6**



7. a) Explain PID controller with its applications. **6**

b) The OLTF is given by $GH = \frac{k(s+1)}{s^2(s+2)(s+5)}$ **8**

find the range of K for stability.

OR

8. For a unity feedback system the open loop transfer function is given by **14**

$$G(s) = \frac{k}{s(s+2)\left(s^2+6s+25\right)}$$

a) Sketch root locus for $0 \le k \le \infty$

b) At what value of 'k' the system becomes unstable.

9. Draw bode plot for the following function **13**

$$G(s)\,H(s) = \frac{80}{s(s+2)(s+20)}$$

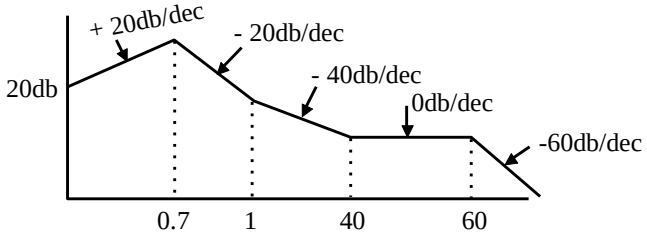
find gain margin & phase margin for stability.

OR

10. a) Draw the polar plot for **6**

$$G(s)\,H(s) = \frac{10}{s(s+1)(s+10)}$$

b) Determine OLTF of a system represented by the following Gain curve on Bode diagram: **7**



11. A system characterized by the transfer function **13**

$$\frac{y(s)}{u(s)} = \frac{2}{s^3+6s^2+11s+6}$$

find the state and output equation in matrix form and also test the controllability and observability of the system.

OR

12. Write short note on: **13**

a) Stability criterion

b) Lead - Lag compensation.

c) Effect of pole - zero placement on system stability.

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B.E. (Mechanical Engineering) Sixth Semester (C.B.S.)

Operations Research

P. Pages : 4 **NRT/KS/19/3481**

Time : Three Hours * 0 6 1 2 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
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7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

1. a) What do you mean by operation Research? Give the detail classification of models in OR. **5**

b) Solve the LPP problem by Graphical method **8**

$\text{Min } Z = 3x_1 + 2x_2$

Subject to constraints

$5x_1 + x_2 \geq 10$

$x_1 + x_2 \geq 6$

$x_1 + 4x_2 \geq 12$

$x_1, x_2 \leq 0$

OR

2. Solve the following LPP by simplex method. **13**

$\text{Maximise } Z = 4x_1 + 3x_2$

Sub to constraint

$2x_1 + 2x_2 \leq 1000$

$x_1 + x_2 \leq 800$

$x_1 \leq 400$

$x_2 \leq 700$

$x_1, x_2 \leq 0$

3. a) A department has five employee with five jobs to be performed. The time (hrs) each men will take to perform to each job is given in effectiveness matrix. **10**

		Employee				
		I	II	III	IV	V
Jobs	A	10	5	13	15	16
	B	3	9	18	13	6
	C	10	7	2	2	2
	D	7	11	9	7	12
	E	7	9	10	4	12

How should the job are allocated, one per employee so as to minimize total man-hours?

b) Explain the Hungarian method for solving assignment type of problem. **3**

OR

4. A company has three distribution centre and 4 outlets. The demand and supply of transportation cost is given in table below. Find the minimum transportation cost between the distribution centre & outlets. **13**

Distribution Centre	Outlets				Supply
	A	B	C	D	
A	10	8	7	12	5000
B	12	13	6	10	6000
C	8	10	12	14	9000
Demand	7000	5500	4500	3000	

5. Write the short notes on **any three.** **14**

i) ABC Analysis.

ii) Saddle point mixed strategy.

iii) Pure strategy & sequencing.

iv) Cost associated with inventory.

OR

6. a) Reduce the following by dominance property z solve it. **7**

		Player B				
		1	2	3	4	5
Player A	1	1	3	2	7	4
	2	3	4	1	5	6
	3	6	5	7	6	5
	4	2	0	6	3	1

b) An Automobile manufacture needs 50 piston per day in his assembly shop. The cost of ordering is Rs. 700/- The Inventory holding cost is Rs. 0.15/unit/day. If the piston cost Rs. 160 and no shortages are permitted. Find. **7**

i) Optimal order quantity.
ii) Optimal total expected total cost.
iii) Sketch the inventory model.

7. A project consist of Ten activity whose time estimates are given below. **14**

Activity	Preceding Activity	t_o	t_m	t_p
A	-	1	2	9
B	A	2	3	4
C	A	2	4	6
D	A	3	5	7
E	C	5	7	9
F	D	1	3	5
G	B	1	4	7
H	G	2	6	10
I	E, H	4	8	7
J	f	2	6	10

i) Construct project network.
ii) Calculate project duration time.
iii) Identify critical path.
iv) Find the probability of completion of project in 21 weeks & 25 weeks.

OR

8. A project consist of seven activity. The normal crash cost and time is given in the table. If indirect cost is Rs. 160/- per day find the optimum project duration. **14**

Activity	Normal		Crash	
	Time (days)	Cost (Rs.)	Time (day)	Cost (Rs.)
1 – 2	3	360	2	400
2 – 3	6	1440	4	1620
2 – 4	9	2160	5	2380
2 – 5	7	1120	5	1600
3 – 4	8	400	4	800
4 – 5	5	1600	3	1770
5 – 6	3	480	2	760

9. Machine A cost Rs. 45000 and operation cost are estimated at Rs. 1000 for first year – increasing by Rs. 10,000 in second & subsequent year. Machine B cost Rs. 50,000 and operation cost is Rs. 2000 for first year and increasing by Rs. 4000 in second and subsequent year. If we now have a machine of type A should we replace it with B? Assume both machine have no resale value & future cost are not discounted. **13**

OR

10. A computer has large no of electronic tube. They are subjected to mortality as given below. **13**

Period	1	2	3	4	5
Age of failure	0-200	201-400	401-600	601-800	801-1000
Probability of failure	0.10	0.26	0.35	0.22	0.07

11. a) Define simulation. Give one application area where this technique used in practice. **7**

b) What is queuing problem? What are the basic characteristic of queuing problem. **7**

OR

12. A company manufacture around 200 vehicles. depending upon the availability of raw material & other conditions the daily production has been varying from 196 vehicles to 204 vehicles whose probability is given below. **14**

Production / day	196	197	198	199	200	201	202	203	204
Probability	0.05	0.09	0.12	0.14	0.20	0.15	0.11	0.08	0.06

The finished vehicle are transported in specially designed to three lorry that can accommodate only 200 vehicles. Using a given 15 random no. 82, 89, 78, 24, 53, 61, 18, 45, 04, 23, 50, 77, 27, 54, 10
Simulate the process to find out.

i) What will be the avg no of vehicles waiting in a factory?
ii) What will be the avg. no. of empty space in lorry?

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B.E. (Mechanical Engineering) Sixth Semester (C.B.S.)

Mechatronics

P. Pages : 2 **NRT/KS/19/3482**

Time : Three Hours * 0 6 1 4 * Max. Marks : 80

Notes :
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5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Illustrate your answers whenever necessary with the help of neat sketches.

1. a) Describe key elements of mechatronics system. **6**

b) Explain mechatronics design process in detail. **7**

OR

2. a) Describe role of mechatronics in ABS (Antilock Braking System) in detail. **7**

b) Differentiate between open loop and closed loop control system. **6**

3. a) What is DSP ? Explain with block diagram. **7**

b) Distinguish between parallel communication and serial communication. **6**

OR

4. a) Explain impedance matching in mechanical system ? State effects of improper impedance matching. **7**

b) Explain interfacing requirements in mechatronics system. **6**

5. a) If a stepper motor has a step angle of 7.5º. Calculate digital input required to produce 10 revolution per second. **7**

b) Explain rotary actuator with neat sketch. **7**

OR

6. a) State types of stepper motor. Explain any one in brief. **7**

b) Explain the principle and working of DC motor with neat sketch. **7**

7.	a)	Using K map simplify $\sum$ (0, 1, 2, 4, 5, 6, 8, 9, 12, 13, 15).	**7**
	b)	Using Boolean algebra write logical expression for f(A, B, C, D) = $\sum$ (0, 1, 2, 4, 5, 6, 8, 9, 12, 13, 15)	**7**

OR

8.		Draw and explain architecture of 8085 microprocessor.	**14**
9.	a)	Draw and explain architecture of PLC.	**7**
	b)	State the common PLC programming methods explain any one in brief.	**6**

OR

10.	a)	Explain criterion for selection of PLC.	**7**
	b)	Explain the application of PLC in control of conveyor motor.	**6**
11.	a)	What is MEMS ? Draw and explain basic block diagram of MEMS.	**7**
	b)	Explain MEMS based pressure sensor in brief.	**6**

OR

12.	a)	State and explain standard TTL characteristics.	**7**
	b)	Describe evaluation and benefits of SCADA.	**6**

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B.E. (Mechanical Engineering / Power Engineering) Sixth Semester (C.B.S.)

Dynamics of Machines

P. Pages : 4 **NRT/KS/19/3483/3509**

Time : Three Hours * 0 6 1 6 * Max. Marks : 80

Notes :
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2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
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5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Assume suitable data whenever necessary.
9. Illustrate your answers whenever necessary with the help of neat sketches.
10. Use of non programmable calculator is permitted.

1. a) Explain the effect of Gyroscopic couple on aeroplane. **4**

b) The mass of the turbine rotor of a ship is 10 tonnes and has a radius of gyration 0.8 m. It rotates at 1600 rpm clockwise when looking from stern. Determine the gyroscopic effect in **9**

i) If the ship travelling at 120 kmph steers to left in a curve of 80 m radius.

ii) If the ship is pitching and the bow is descending with the maximum velocity. The pitch is SHM, the periodic time is 20 seconds. The total angular movement between the extreme positions is 10^{o}.

iii) If the ship is rolling and at a certain instant has an angular velocity of 0.04 rad/sec clockwise when looking from stern.

iv) Also find maximum angular acceleration during pitching.

OR

2. a) State and explain D'Alembert principle. **3**

b) Each wheel of a four wheeled rear engine automobile has a moment of inertia $2.4\,kg\,m^2$ and an effective diameter of 660 mm. The rotating parts of the engine have a moment of inertia $1.2\,kg\,m^2$. The gear ratio of engine to the back wheel is 3 : 1. The engine axle is parallel to the rear axle and the Crankshaft rotates in the same sense as the road wheels. The mass of the vehicle is 2200 kg and the centre of mass is 550 mm above the road level. The track width of the vehicle is 1.5 m. Determine the limiting speed of the vehicle around a curve with 80 m radius so that all the four wheels maintain contact with the road surface. **10**

3. For the fig. 3 shown, determine the drive torque required to be applied on Crank O_2A to overcome an inertia effect of link AB having mass 4.2 kg the centre of gravity at 330 mm from A and a mass moment of inertia $0.152\,kg-m^2$. **14**

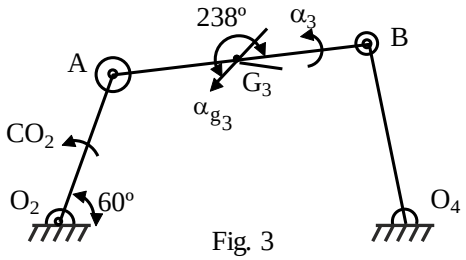


Fig. 3

$O_2A = 500\,mm$; $AB = 660\,mm$;

$O_4B = 560\,mm$; $O_2O_4 = 1000\,mm$

acceleration of G_3 as shown in fig. is $16\,m/s^2$ and angular acceleration $\alpha_3 = 34.1\,rad/s^2\,(ccw)$.

OR

4. A plate cam drives a reciprocating follower through a distance of 40 mm with simple harmonic motion in 120° cam rotation and return with the parabolic motion in 180°. The dwell between rise and return is 30° and the parabolic motion is with equal acceleration and retardation. The load on the cam is 50 N. and the mass of the follower is 2.5 kg. The stiffness of spring is 4 kN/m. Determine the speed at which the follower begins to lift from the cam surface. Also draw displacement, velocity, and acceleration diagram showing the angular position of cam where the lift begins. **14**

5. Four masses A, B, C and D as shown below are to be completely balanced. **13**

	A	B	C	D
Mass (kg)	--	30	50	40
Radius (mm)	180	240	120	150

The planes containing masses B and C are 300 mm apart. The angle between the planes containing B and C is 90°, B and C making angles of 210° and 120° respectively with D in the same sense. Find

i) The magnitude and angular position of mass A and

ii) The position of planes A and D.

OR

6. The following data refer to two cylinder locomotive with Cranks at 90° Reciprocating mass per cylinder = 300 kg **13**
Crank radius = 0.3 m
Driving wheel diameter = 1.8 m
Distance between cylinder centre lines = 0.65 m.
Distance between the driving wheel centre planes = 1.55 m. Determine

i) The fraction of the reciprocating masses tobe balanced, if the hammer blow is not to exceed 46 kN at 96.5 kmph

ii) The variation in tractive effort &

iii) The maximum swaying couple.

7. The turning moment curve for an engine is represented by the equation $T = (20,000 + 9500\sin 2\theta - 5700\cos 2\theta)\,N-m$ where θ is the angle moved by the Crank from inner dead centre. If the resisting torque is constant, find : **13**

i) Power developed by the engine.

ii) Moment of inertia of the flywheel in $kg-m^2$, if the total fluctuation of speed is not to exceed 1% of mean speed which is 180 rpm and

iii) Angular acceleration of the flywheel when the Crank has turned through 45° from inner dead centre.

OR

8. a) With the help of neat sketch explain the working of Hartnell Governor. **6**

b) A porter governor has all four arms 30 cm long. The upper arms are pivoted on the axis of rotation and the lower arms are attached to the sleeve at a distance of 3.5 cm from the axis. Mass of each ball is 7 kg and the mass of the sleeve is 50 kg. Determine the equilibrium speeds for the two extreme radii of 20 cm and 24 cm of rotation of the governor balls and the range of speed. **7**

9. a) Explain the following terms : **6**

i) Longitudinal vibration.

ii) Transverse vibration.

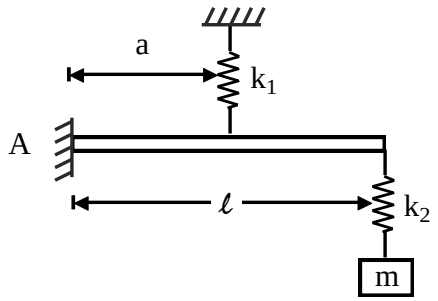
iii) Torsional vibration

b) A steel shaft, 10 cm diameter supported by bearings. 1.2 m apart carries 2 pulleys weighing 300 N and 800 N are placed 0.25 m and 0.65 m from left hand bearing respectively. Determine the critical speed of the shaft. Take $E = 2\times10^{11}\,N/m^2$. **7**

OR

10. a) A mass of 1 kg is tobe supported on a spring having constant of $K = 9800\,N/m$. The damping coefficient is $4.9\,N-s/m$. Determine the damped natural frequency of the system. Find also the logarithmic decrement and amplitude of vibration after 8^{th} cycle if the initial displacement is 0.4 cm. **6**

b) Determine the expression for natural frequency of the system shown in fig. 10 (b). **7**



11. a) Explain what is meant by torsionally equivalent shaft system. **4**

b) A centrifugal pump rotating at 400 rpm is driven by an electric motor at 1200 rpm through a single stage reduction gearing. The moments of inertia of the pump impeller and the motor are $1500\,kg-m^2$ and $450\,kg-m^2$ respectively and the lengths of the pump shaft and motor shaft are 500 mm and 200 mm and diameters are 100 mm and 50 mm respectively. Neglecting the inertia of the gears, find the frequency of torsional vibration of the system. Take $G = 85\,GN/m^2$. **10**

OR

12. a) Explain FFT analyser in short. **4**

b) There rotors A, B and C having moment of inertia $2000\,kg\,m^2$, $6000\,kg\,m^2$ and $3500\,kg-m^2$ respectively are carried on a uniform shaft of 0.35 m diameter. The length of the shaft between the rotor A and B is 6 m and between B and C is 32 m. Find the natural frequency of the torsional vibration. Take $G = 80\,GN/m^2$. **10**

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B.E. (Mechanical Engineering / Power Engineering) Sixth Semester (C.B.S.)

Energy Conversion-I

P. Pages : 3 **AHK/KW/19/2243/2269**

Time : Three Hours * 1 0 8 3 * Max. Marks : 80

Notes : 1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Assume suitable data whenever necessary.
9. Use of steamtable, Mollier chart is permitted.

1. a) What are the features of high pressure boiler ? Name the different types. Explain the construction and working of Benson boiler with neat sketch. **7**

b) Explain with neat sketch - **6**
i) Air Pre heater
ii) Fusible plug

OR

2. a) Classify fuels used for steam generators and state the necessity of water treatment in a steam generating units. **7**

b) Discuss in brief functions of Economiser with well labelled diagram. **6**

3. a) A steam generator evaporates 18000 kg of steam per hour of a pressure of 12.5 bar and a quality of 0.97 dry from feed water at 105ºC, when coal is fired at 2040 kg/hr. If the higher calorific value of coal is 27400 kJ/kg, find - **10**
i) heat rate of the boiler in kJ/hr
ii) equivalent evaporation, and
iii) thermal efficiency.

b) Define evaporation capacity. Equivalent evaporation and Boiler efficiency. **4**

OR

4. A chimney of 40 meters height deals with flue gas at 350ºC when the outside air temperature is 30ºC. The air supplied at the rate of 18 kg per kg of fuel. Calculate : **14**
i) draught produced in term of mm of water.
ii) draught produced in term of column of hot gases.
iii) efficiency of the chimney if minimum temperature of artificial draught is 150ºC the mean specific heat of flue gases is 1.005 kJ/kg k.
iv) the percentage of heat spent in natural draught system, if the net calorific value of the fuel supplied be 30600 kJ/kg and
v) the temperature of chimney for maximum discharge in a given time and what would be the corresponding draught in mm of water produced.

5. Write short notes on **any two.** **13**

i) Ash handling system.

ii) Bubbling fluidized bed boilers.

iii) Circulating fluidized bed boiler.

OR

6. a) Explain with neat sketch coal handling system. **7**

b) Explain topping cycle and bottoming cycle with neat sketch. **6**

7. A steam nozzle supplied a steam at 15 bar and 350ºC and exits at 1 bar. If the divergent portion of the nozzle is 80 mm long and the throat diameter is 6 mm. Determine the cone angle of the divergent portion. Assume 12% of total enthalpy drop is lost in the friction in the divergent portion. Also calculate the velocity and condition of steam at throat. **14**

OR

8. a) Explain with the help of neat sketch, working of single stage impulse turbine. Sketch pressure velocity variation along the axis of the turbine. **5**

b) Steam is supplied to a de-Laval turbine at a velocity of 1000 m/s at an angle of 20º. The blade velocity is 300 m/s and the blades are symmetrical. The mass of steam flowing through turbine per hour is 1800 kg. Allowing a friction factor of 0.8. **9**
Determine :
i) Blade efficiency
ii) Blade angle
iii) Power developed
iv) Stage efficiency if nozzle efficiency is 95%.

9. a) Derive the expression of maximum blade efficiency in a single stage impulse turbine. **7**

b) Explain the term "Degree of Reaction" used in the reaction turbine. Also show degree of reaction is 50% for reaction turbine. **6**

OR

10. a) In a reaction turbine the blade tips are inclined at 35º and 20º in the direction of motion. The guide blades are of the same shape as the moving blades but reversed in direction. At a certain place in the turbine, the drum diameter is 1 meter and the blades are 10 cm height. At this place steam has a pressure of 1.75 bar and dryness 0.935. if speed of the turbine is 250 rpm and the steam passes through the blades without shock. Find the mass of steam flow and power developed in the ring of moving blades. **9**

b) What is the pressure velocity compounding ? Write its advantages. **4**

11. a) Explain the working of a natural draft cross flow cooling tower with neat sketch. **5**

b) The following observations were taken during test on condenser : **8**

i) Barometric reading = 760 mm of Hg
ii) Condenser vacuum = 705 mm of Hg
iii) Mean temperature of condensate = 35ºC
iv) Condensate collected = 2000 kg/hr
v) Quantity of cooling water circulated = 60000 kg/hr
vi) Rise in temperature of cooling water = 16ºC
vii) How wall temperature = 28ºC

Determine :

i) Vacuum efficiency
ii) condenser efficiency
iii) Quality of steam entering the condenser
iv) Degree of under cooling.

OR

12. a) A surface condenser is designed to handle 10000 kg of steam per hour the steam enters at 0.08 bar and 0.9 dryness and the condensate leaves at the corresponding saturation temperature. The pressure is constant throughout the condenser. Estimate the cooling water flow rate per hour, if the cooling water temperature rise is limited to 10ºC. Take Cp of water 4.184 kJ/kg k. **7**

b) Explain the Dalton's law of partial pressure. **3**

c) Explain the effect and sources of air leakage in the condenser. **3**

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B.E. (Mechanical Engineering) Sixth Semester (C.B.S.)

Control System Engineering

P. Pages : 4 **AHK/KW/19/2244**

Time : Three Hours * 1 0 8 1 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

1. a) State different types of actuators used in control system. Explain any one type of actuator with neat sketch. **6**

b) **8**

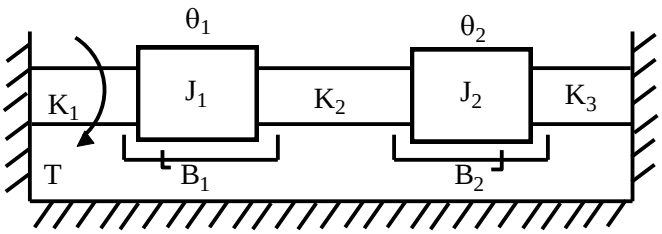

Fig. 1 b

Calculate $\frac{\theta_1}{T}$ and $\frac{\theta_2}{T_1}$ for the system as shown in Fig. 1.b.

OR

2. a) Find $\frac{E_o(s)}{E_i(s)}$. **6**

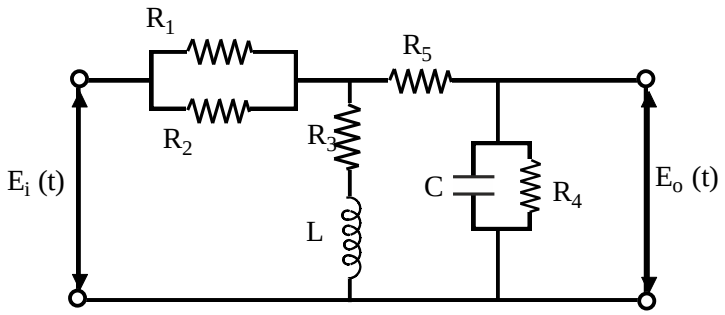

Fig. 2 (a)

b) Write equation of motion of translational mechanical system shown in Fig. 2 (b) and determine transfer function. **8**

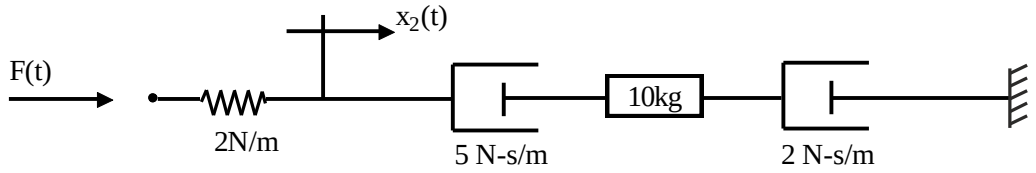

Fig. 2 (b)

3. a) Explain following terms with respect to signal flow graph. **5**

i) Forward path ii) Feedback path
iii) Source Node iv) Sink Node
v) Self Loop

b) Obtain $\frac{C(s)}{R(s)}$ using block reduction technique. **8**

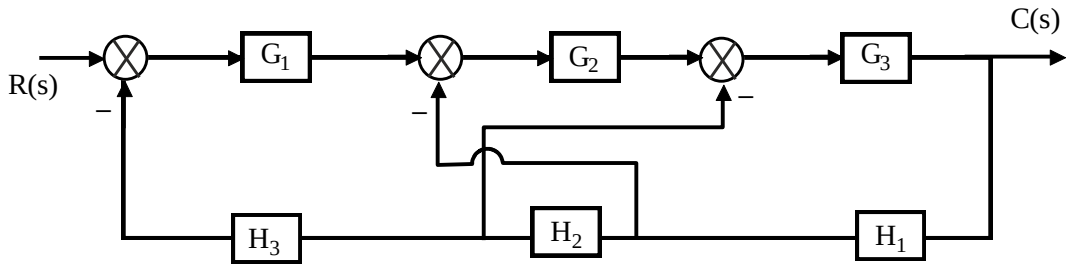

Fig. 3 (b)

OR

4. a) Using Mason's Gain Formula Obtain $\frac{C(s)}{R(s)}$ for the system as shown in Fig. 4 (a). **6**

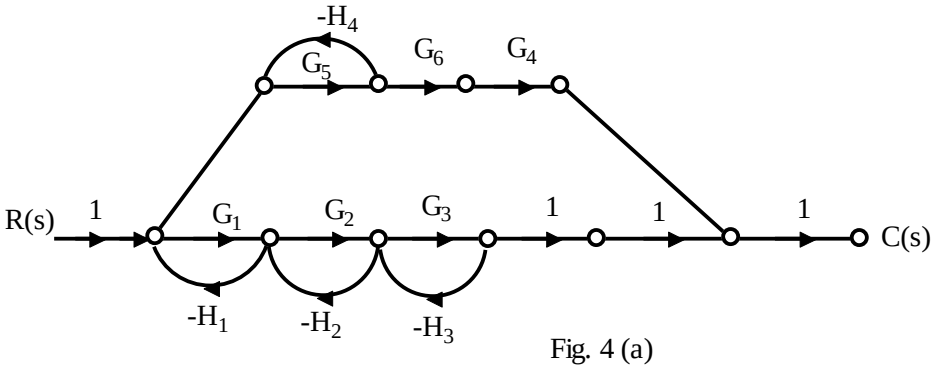

Fig. 4 (a)

b) Construct Signal flow graph for the following equations and obtain the transfer function. **7**

$x_2 + 3x_3 - 3x_1 = 0$

$x_3 + 4x_4 - 4x_2 = 0$

$x_4 - 5x_3 = 0$

where, x_1 is input and x_4 is output.

5. a) Explain the role of P.I.D. controller in a feedback system. **6**

b) Determine the $\text{T.F.} = \frac{x(s)}{F(s)}$ for the system as shown in Fig. 5 (b) and find time domain specifications. **7**

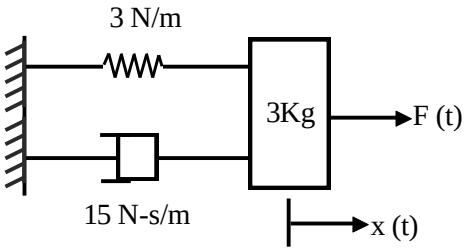

Fig. 5 (b)

OR

6. a) Derive an expression for unit step response of first order system. **6**

b) The block diagram of Fig. 6 (b) represents a radar antenna drive. **7**

i) If R is the ramp input and R (t) = 0.1t rad/s, then what is the steady state position error?

ii) If R = 0 and system standstill. Assume that wind blows applies a load torque of $T_L = 0.2$ what is steady state error.

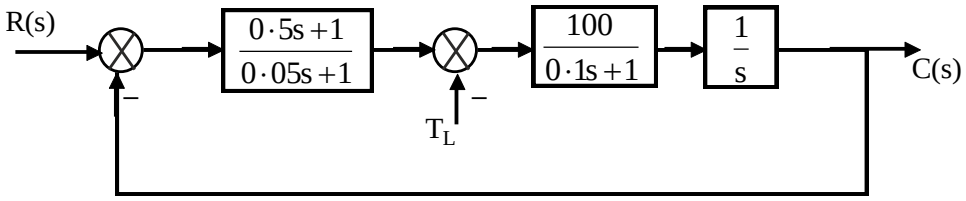

Fig. 6 (b)

7. a) For the Transfer function having characteristic equation **7**

$1+G(s)\,H(s) = s^4+3s^2+6s+10 = 0$

find the stability of the system using Routh's Criterion.

b) For the unity feedback system with **7**

$$G(s) = \frac{k}{(s+1)^3(s+4)}$$

i) Find range of k for stability.

ii) Find the frequency of oscillations when the system is marginally stable.

OR

8. The transfer function of a unity feedback control system is. **14**

$$G(s)H(s) = \frac{k}{s(s+2)(s+5)}$$

Sketch the root locus of the system and determine value of k for.

i) Critical damping

ii) Marginal stability from the root locus.

9. Consider the loop transfer function of a closed loop as. **13**

$\frac{100k(s+5)(s+40)}{s^3(s+100)(s+200)}$, Draw Bode plot for k = 1. Find gain crossover frequency and phase margin.

OR

10. a) With necessary diagrams explain the following terms. **6**

i) Gain cross-over frequency
ii) Phase cross-over frequency
iii) Gain margin
iv) Phase margin

b) Draw the polar plot and determine if system is stable and its gain and phase margin for the function. **7**

$$G(s)H(s)=\frac{12}{s(s+1)(s+2)}$$

11. a) Explain the terms controllability and observability. **5**

b) Find T.F. of the system check whether the system is observable and controllable or not. **8**

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & 6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad Y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

OR

12. a) Explain Phase Lead-lag Compensation. **5**

b) Find the state space representation of system where T.F. is given by. **8**

$$\frac{Y(s)}{U(s)} = \frac{2}{s^3+6s^2+11s+6}$$

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B.E. (Mechanical Engineering) Sixth Semester (C.B.S.)

Operations Research

P. Pages : 4 **AHK/KW/19/2245**

Time : Three Hours * 1 0 8 0 * Max. Marks : 80

Notes : 1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.

1. A firm uses lathes, milling machines and grinding machine to produce two machine parts. Table represents the machining times required for each part, the machining times available on different machines and the profit on each machine part - **14**

Types of Machine	Machining time required for the machine parts (minutes)		Maximum time available per week (minutes)
	I	II	
Lathes	12	6	3,000
Milling m/c	4	10	2,000
Grinding m/c	2	3	900
Profit / Unit	Rs. 40	Rs. 100	

Find the number of Part I & Part II to manufactured per week to maximize profit.

OR

2. Solve using simplex method **14**

Maximize $Z = 5x_1 - 2x_2 + 3x_3$

subject to,

$$2x_1 + 2x_2 - x_3 \geq 2$$
$$3x_1 - 4x_2 \leq 3$$
$$x_2 + 3x_3 \leq 5$$
$$x_1, x_2, x_3 \geq 0$$

3. A salesman wants to visit cities 1, 2, 3, 4. He does not want to visit any city twice before completing the tour of all the cities and wishes to return to his home city, the starting station cost of going from one city to another city in rupees is given in table. Find least cost route by brand & boonel method. **13**

		(To city) 1	2	3	4
From city	1	–	3	8	5
	2	4	–	14	3
	3	4	5	–	2
	4	7	8	13	–

OR

4. A company has factories at A, B, C which supply warehouses at D, E, F, G. The factory capacities are 230, 280 & 180 respectively for regular production. If overtime production is utilized the capacities can be increased to 300, 360 & 190 respectively. Increment unit overtime costs are Rs.5, Rs.4 & Rs.6 respectively. The current warehouse requirements are 165, 205 and 165 respectively. Unit shipping cost in rupees between factories and warehouses are, **13**

To / From	D	E	F	G
A	6	7	8	10
B	4	10	7	6
C	3	22	2	11

Determine optimum distribution to minimize cost.

5. a) A stockiest has to supply 400 units of a product every Monday to his customers. He gets the product at Rs.50 per unit from the manufacturer. The cost of ordering & transportation from the manufacturer is Rs.75 per order. The cost of carrying inventory is 7.5% per year of the cost of the product. Find : **6**

i) EOQ ii) Total optimal cost

iii) Total weekly profit if the item is sold for Rs.55 per unit.

b) There are seven jobs, each of which has to go through the machine A & B in the order A-B. Processing times in hours are given as - **7**

Job	1	2	3	4	5	6	7
Machine A	3	12	15	6	10	11	9
Machine B	8	10	10	6	12	1	3

Determine a sequence of these jobs that will minimize the total elapsed time. Also find total elapsed time & idle time for machine A & B.

OR

6. a) Reduce the following game by dominance property and solve it. **7**

		Player B				
		1	2	3	4	5
Player A	I	1	3	2	7	4
	II	3	4	1	5	6
	III	6	5	7	6	5
	IV	2	0	6	3	1

b) Write short notes on **any two.** **6**

i) ABC Analysis.

ii) Cost Associated with Inventory.

iii) Sequencing.

7. The time estimates (in weeks) for the activities of a PERT network are given below. **14**

Activity	t_o	t_m	t_p
1 - 2	1	1	7
1 - 3	1	4	7
1 - 4	2	2	8
2 - 5	1	1	1
3 - 5	2	5	14
4 - 6	2	5	8
5 - 6	3	6	15

i) Draw the project network & identity all paths through it.
ii) Determine expected project length.
iii) The probability that the project will be completed on schedule if the scheduled completion time is 20 week.
iv) What should be the scheduled completion time for the probability of completion to be 90%.

OR

8. The following table gives data on normal time & cost and crash time and cost for a project. **14**

Activity	Normal		Crash	
	Time (days)	Cost (Rs.)	Time (days)	Cost (Rs.)
1 - 2	6	60	4	100
1 - 3	4	60	2	200
2 - 4	5	50	3	150
2 - 5	3	45	1	65
3 - 4	6	90	4	200
4 - 6	8	80	4	300
5 - 6	4	40	2	100
6 - 7	3	45	2	80

Indirect cost perday is Rs.10
i) Draw the network for project.
ii) Find critical path.
iii) Determine minimum total time & corresponding cost.

9. A truck owner estimates that the running cost and salvage value of truck for various years as tabulated below. If purchase price of truck is Rs.1,60,000. Estimate optimal replacement age. Assume a rate of return on capital invested to 25% per year. Also assume running cost incurred in the beginning of the year. **13**

Year (k)	1	2	3	4	5	6	7	8
Running cost (R_k) in Rs.	12000	15000	18000	24000	30000	40000	55000	75000
Salvage value (S_k) in Rs.	120000	80000	60000	60000	50000	40000	40000	4000

OR

10. A computer contains 10,000 resistors when any resistor falts it is replaced. The cost of replacing a resistor individually is Rs.1 only. If all the resistors are replaced at the same time, the cost per resistor would be reduced to 35 paise. The percent surviving at the end of month 't' is given in the table below. What is the optimum period of replacement. **13**

Month	0	1	2	3	4	5	6
Percent surviving at the end of month (t)	100	97	90	70	30	15	0

11. Automobiles arrive at a petrol pump having petrol filling unit in poissons fashion with an average of 10 units/hour. The service time is distributed exponentially with a mean of 3 minutes. Find : **13**

i) Average no of units in the system.
ii) Average waiting time for a customer.
iii) Average length of queue.
iv) Probability that the customer arriving at petrol pump will have to wait.
v) Probability that no of units in the system is 2.
vi) Utilization factor for pump unit.

OR

12. A dentists schedules all his patients for 30 minute appointments some of the patients take more or less than 30 minutes depending on the type of dental work to be done. The following summary shows the various categories of work, their probabilities & time actually needed to complete the work. **13**

Category of service	Time required (minutes)	Probability of category
Filling	45	0.40
Crown	60	0.15
Cleaning	15	0.15
Extraction	45	0.10
Check-up	15	0.20

Simulate the dentists clinic for four hours and determine the average waiting time for patients as well as idleness of doctor. Assume that all the patients show up at the clinic at exactly their scheduled arrival time starting at 8.00 am. Use following random numbers for handling, the above problem.
40, 82, 11, 34, 25, 66, 17, 79.

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B.E. (Mechanical Engineering) Sixth Semester (C.B.S.)

Mechatronics

P. Pages : 2 **AHK/KW/19/2246**

Time : Three Hours * 1 0 8 2 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.

1. a) Explain in detail mechatronics design process. **6**

b) Explain the following : **7**

i) Boat Auto Pilot

ii) High speed Tilting Train

OR

2. a) Differentiate between open loop and closed loop control system. **6**

b) Explain with neat sketch mechatronic system used in automatic washing machine. **7**

3. a) What is digital communication? Explain modes of serial communication. **7**

b) What is DAQS? Enlist and explain its types. **6**

OR

4. a) What is Digital to Analog converter? Explain ladder type Digital to Analog converter. **6**

b) Explain the term Digital Communication. Also explain various types of serial communication. **7**

5. a) Differentiate stepper motor and servomotor. **7**

b) Explain principle and working of Brushless D.C. motor. **7**

OR

6. a) Explain Rotary actuator with neat sketch. **7**

b) Explain flow various valves are classified. Also write down working principle of pressure control valve. **7**

7. a) Simplify following function using k – map. **7**

$f(A,B,C,D) = \Sigma(0,1,5,7,8,9,12,14,15) + d(3,11,13)$

b) Using Boolean law simplify the following expressions **7**

i) $X = A \cdot B \cdot \overline{C} + A \cdot B \cdot C + \overline{AB}$

ii) $Y = (A+B)(A+C)$

OR

8. Draw and explain Architecture of $8085\mu p$. **14**

9. a) Draw and Explain Block diagram of PLC. **6**

b) Explain shift register with suitable diagram. **7**

OR

10. a) Explain Master control, Jump control in reference of PLC. **6**

b) Explain the application of PLC in control of conveyor motor. **7**

11. a) Describe functionality and benefits of SCADA. **6**

b) Explain the term "TTL logic" in details. **7**

OR

12. a) What are MEMS? Draw the basic block diagram of MEMS and explain it. **6**

b) Explain in brief motor isolation scheme. **7**

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B.E. (Mechanical Engineering / Power Engineering) Sixth Semester (C.B.S.)

Dynamics of Machines

P. Pages : 4 **AHK/KW/19/2247/2273**

Time : Three Hours * 1 0 8 4 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

1. a) Define Applied torque and Reaction torque. State D' Alembert principle. **3**

b) The rotor of the turbine of a ship has a mass of 2500 kg and rotates at a speed of 3200 rpm counter clockwise when viewed from stern. The rotor has a radius of gyration of 0.4m. Determine the gyroscopic couple and its effect when **10**

i) Ship steers to the left in a curve of 80 m radius at a speed of 15 knots. (1 knot = 1860 m/h)

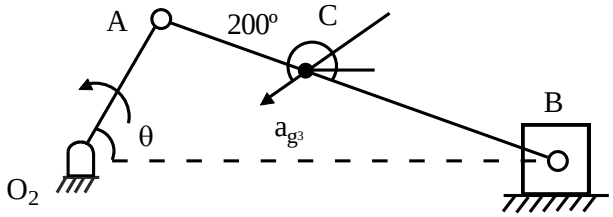
ii) Ship pitches 5 degrees above and 5 degrees below the normal position and bow is descending with its maximum velocity, the pitching motion is S.H.M. with a periodic time of 40 seconds.

iii) Ship rolls and at the instant, its angular velocity is 0.4 rad/sec clockwise when viewed from stern. Also find maximum angular acceleration during pitching.

2. a) Define Dynamic forces? How dynamic forces are developed in mechanical system? **3**

b) A four – wheeled trolley car has a total mass of 3000 kg. Each axle with its two wheels and gears has a total moment of inertia $32\,kg-m^2$. Each wheel is of 450 mm radius. The centre distance between two wheels on an axle is 1.4 m. Each axle is driven by a motor with a speed ratio of 1 : 3 each motor along with its gear has a moment of inertia of $16\,kg-m^2$ and rotates in the opposite direction to that of the axle. The centre of mass of the car is 1m above the rails. Calculate the limiting speed of the car when it has to travel around a curve of 250 m radius without the wheels leaving the rails. **10**

3. Determine the input torque required to overcome the inertia forces & torques for the mechanism shown in fig. **13**



$O_2A = 300\,mm, AB = 900\,mm, \theta = 40^o$

mass of link $AB = 3kg, AC = 450\,mm$

$J_{AB} = 0.2\,kg\,m^2, a_{g_3} = 100\,m/s^2, \alpha_3 = 150\,rad/s^2$ (ccw)

4. a) Explain centre of percussion and how it is useful in sports application like cricket bat or baseball bat design? **4**

b) In a cam mechanism following are the specification : **10**
Cam speed is 1800 rpm, follower stroke is 60 mm, Cam angles for out stroke and return stroke are 130º and 90º respectively. Follower is moving with parabolic motion during accent and with SHM during descend. Mass of follower is 4.2 kg with preload of 30 N. Determine the necessary spring stiffness so as to ensure the contact of the follower and cam throughout the cycle of motion of the mechanism.

5. a) i) Discuss active balancing and Passive balancing. **3**

ii) Does a rotor which is statically balanced requires dynamic balancing?

b) A shaft carries four masses A, B, C and D which are placed in parallel planes perpendicular to the longitudinal axis. The unbalanced masses at planes B and C are 3.6 kg and 2.5 kg respectively and both are assumed to be concentrated at a radius of 25 mm while the masses in planes A and D are both at radius of 40 mm. The angle between the planes B and C is 100º and that between B and A is 190º, both angles being measured in CCW direction from plane B. The planes containing A and B are 250 mm apart and those containing B and C are 500 mm. If the shaft is to be completely balanced, determine : **10**

i) masses at planes A and D
ii) Distance between planes C and D
iii) Angular positions of mass D.

6. a) Explain the reason for not complete balancing the disturbing effect due to the reciprocating masses in reciprocating engine mechanism. **3**

b) The Cranks and connecting rods of a 4 – cylinder in – line engine running at 1800 rpm are 60 mm and 240 mm each respectively and the cylinders are spaced 150 mm apart. If the cylinders are numbered 1 to 4 in sequence from one end, the Cranks appear at intervals of 90º in an end view in the order 1 – 4 – 2 – 3. **10**
The reciprocating mass corresponding to each cylinder is 15 kg.
Determine :

i) Unbalanced primary and secondary forces, if any and
ii) Unbalanced primary and secondary couples with reference to central plane of the engine.

7. a) Explain the function of a flywheel with reference to turning moment diagram. **3**

b) A single cylinder four stroke petrol engine develops 20 kw at 600 rpm. The mechanical efficiency of the engine is 80% and work done by the gases during expansion stroke is three times the work consumed in compression stroke. If the total fluctuation of speed is not to exceed ± 1.5 percent of the mean speed and turning moment diagram during expansion stroke is assumed to be triangular. Determine moment of Inertia of the flywheel. **10**

8. a) i) State the function of Governor. How is it different from that of a flywheel? **2**

ii) Discuss the influence of friction at the sleeve on the performance of a governor. **2**

b) The length of upper and lower arms of a porter governor are 200 mm and 250 mm respectively. Both the arms are pivoted on the axis of rotation. The sleeve weight is 150N, the weight of each ball is 20N and the friction resistance is equivalent to a force of 30 N at the sleeve. If the limiting inclination of the upper arms to the vertical are 30º and 40º, determine the range of speed of the governor. **9**

9. a) Determine the natural frequency of the system as shown in fig. 9 (a). **7**

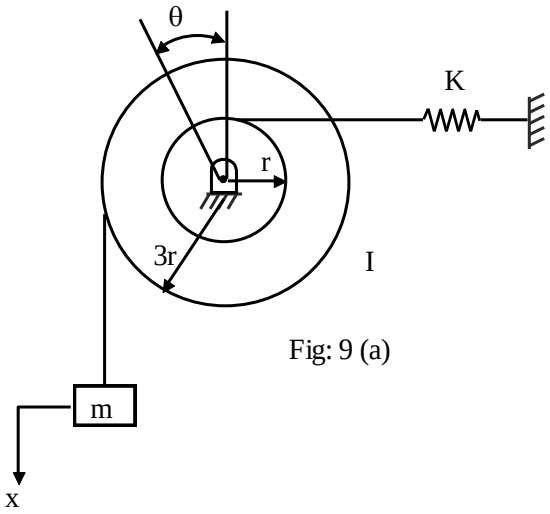


Fig: 9 (a)

b) In a single – degree damped vibrating system, a suspended mass of 8 kg makes 30 oscillations in 18 seconds. The amplitude decreases to 0.25 of the initial value after 5 oscillations. **7**

Determine the :

i) Stiffness of the spring
ii) Logarithmic decrement
iii) Damping factor
iv) Damping coefficient

10. a) A shaft 40 mm dia and 2.5 m long has a mass of 15 kg per meter length. It is simply supported at the ends and carries three masses 90 kg, 140 kg and 60 kg at 0.8 m, 1.5 m and 2 m respectively from the left support. Taking $E = 200\,GN/m^2$. Find the frequency of transverse vibration. **7**

b) Explain : **6**

i) Whirling of shaft

ii) Vibration isolation and transmissibility.

11. a) Write short notes on : **6**

i) Vibration Absorber

ii) FFT Analyzer

b) Figure 11 (b) shows two degrees of freedom system. The quantities x_1 and x_2 are absolute displacements. Find the two natural frequencies when $k_1 = 98000\,N/m$, $k_2 = 19600\,N/m$ $m_1 = 196\,kg$ and $m_2 = 49\,kg$. **7**

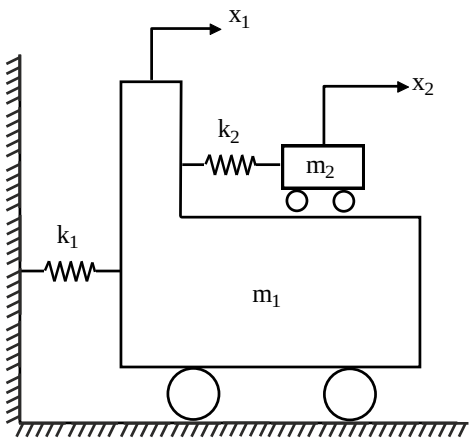


Fig: 11 (b)

12. A steel shaft ABCD of 1.5 m length has flywheel at its ends, A and D. The mass of the flywheel A is 5886 N and has a radius of gyration of 0.6 m. The mass of the flywheel D is 7848 N and has a radius of gyration of 0.9 m. The connecting shaft AB is 0.4 m long and has a diameter of 50 mm, a diameter of 60 mm for the portion BC which is 0.5 m long and a diameter of 'd' mm for the portion CD which is 0.6 m long. **13**

Determine :

a) the diameter 'd' of portion CD so that the node of the torsional vibration of the system will be at the centre of the length BC.

b) the natural frequency of the torsional vibrations. The modulus of rigidity for the material of the shaft is $0.785\times10^{11}\,N/m^2$.

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