

JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
[A GOVERNMENT AUTONOMOUS COLLEGE]
JGEC/B.TECH/ ME/ 7th Sem./OE-ME701J/ 2024-25
2024
WASTE TO ENERGY –AN OVERVIEW

Full Marks: 70

Times: 3 Hours

The figures in the margin indicate full marks.
Candidates are instructed to write the answers in their own words as far as practicable.

GROUP-A
[OBJECTIVE TYPE QUESTIONS]

Answer *all* questions

5x2=10

1. Explain "Waste to Energy" in brief.
2. What is "Waste Electricity"?
3. Define RDF.
4. What is MSW?
5. Define syngas.

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

Answer any *four* questions

4x15 = 60

- ✓ 6.
 - i) Discuss classification of "Waste" based on different parameters. 5
 - ii) What are the advantages and disadvantages of RDF? 5
 - iii) Write a short note on the composition of MSW according to their materialistic nature. 5
- ✓ 7.
 - i) Write a short note on "Waste" Energy Content & compare with other fuels. 7
 - ii) Describe different types of MSW depending on the source. 8
- ✓ 8.
 - i) Explain different types of "Waste to Energy Technologies". 7
 - ii) Describe the preparation process of RDF from MSW. 8
9.
 - i) Calculate the stoichiometric air required for combustion of MSW based on the principles of combustion. 6
 - ii) Explain different types of Traditional Waste Combustion Technologies. 9
10.
 - i) Calculate the theoretical air and oxygen required for a typical MSW mass burn process based on below tabulated value. 7
 - ii) Also calculate the total products of combustion at 0% and 100 % excess air. 8

Component	% by weight
Carbon	30.0
Hydrogen	4.0
Oxygen	20.0
Nitrogen	0.5
Sulfur	0.3
Chlorine	0.5
Ash	21.0
Moisture	23.7
Total	100.0

* Specific humidity of air at 27° C and 60% relative humidity gives 0.013 Kg of moisture per Kg of dry air.

- ✓ 11.
 - i) What are the differences between gasification and pyrolysis? Explain with reference to Enthalpy vs. Reaction coordinates. 8
 - ii) Compare the gasification and combustion systems based on the combustion temperature and different air fractions (equivalence ratio and excess air). 7

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JGEC/B.TECH/ ME/ PC-ME701/ 2024-25

2024

Advanced Manufacturing Technology

Full Marks: 70

Times: 3 Hours

*The figures in the margin indicate full marks.
Candidates are instructed to write the answers in their own words as far as practicable.*

GROUP-A

[OBJECTIVE TYPE QUESTIONS]

Answer *all* questions

5x2=10

1. Briefly write the importance of using non-conventional machining. 2
2. Justify that abrasive jet machining (AJM) process is unsuitable for soft material. 2
3. What are the functions of dielectric fluid used for electric discharge machine (EDM) process? 2
4. Briefly explain the mechanism of material removal process in electro chemical grinding (ECG). 2
5. Write the name of machining process where 'masking' is required and explain the use of maskant. 2

GROUP-B

[LONG ANSWER TYPE QUESTIONS]

Answer any *four* questions

4x15= 60

6. (i) Draw and label schematic diagram of electron beam machining (EBM) equipment. 6
- (ii) Why electron beam machining (EBM) is suitable for small size workpiece and write advantages of EBM. 4
- (iii) In an EDM process, the breakdown voltage across inter electrode gap (IEG) is 200 V and the capacitance of the RC circuit is 100 μ F. Calculate the energy (in J) released per spark across the inter electrode gap. 5
7. (i) Write the various types of energy sources used in non-traditional machining techniques with examples for each type. 5
- (ii) A 3 mm thick steel sheet kept at 30°C is cut by LASER beam. The beam spot diameter is 0.2 mm on surface and absorptivity of sheet is 50%. The density of steel 7800 kg/m³, specific heat 450 J/kg°C, melting temperature 1530°C, latent heat of fusion 3×10^5 J/kg, melting efficiency is 100%, kerf width and spot diameter are equal. Laser power is 2000 W. Calculate the maximum speed (m/s). 6
- (iii) Abrasive jet, plasma arc, laser beam, electric discharge machines are available in a workshop. Which is the most appropriate method to drill a hole of cross section of 6X6 mm and 25 mm deep? Justify your answer. 4
8. (i) In an abrasive jet machining, the total material removal rate (MRR) for flow rate 'Q' of abrasives and the mean diameter 'd' of the abrasive is 20 mm³/s. If the flow rate of abrasives is tripled and the mean diameter of the abrasives is halved, then calculate the MRR. 6
- (ii) Write the machining parameters and response parameters of abrasive jet machining (AJM). 5
- (iii) Explain the effects of mixing ratio of abrasive and carrier gas on material removal rate of AJM process. 4
9. (i) An electron beam machining uses a 15 mA beam current at an accelerating voltage of 10 kV. Calculate the energy released by the beam per second. 5
- (ii) Which dielectric medium is used in wire electric discharge machining (WEDM) process? Also mention the purpose of that dielectric medium in brief. 5
- (iii) With suitable sketch explain the term 'Kerf Width' in WEDM operation? 5
10. (i) During the electro chemical machining (ECM) of iron (atomic weight 56, valency 2) at current 1000 A with 90% current efficiency, MRR observed as 0.26 g/s. If Titanium (atomic weight 48, valency 3) is machined by ECM at current of 1800A with 90% current efficiency, find the expected MRR in g/s. 4
- (ii) Explain the working principle of ultrasonic machining (USM) with feasible diagram. 5
- (iii) Write the process parameters of abrasive flow machining and write three major elements of the process. 6
11. (i) Explain magneto-rheological finishing (MRF) process with neat sketch. 6
- (ii) Explain the necessity for introducing micro-machining processes in advanced manufacturing industries? 4
- (iii) Briefly explain the chemo-mechanical polishing (CMP) mechanism with necessary diagram. 5

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COE/B.TECH./ME/PE-ME701A4/2024-25
2024

Refrigeration and Air-Conditioning

Full Marks: 70

Time: 3 Hours

The figures in the margin indicate full marks. Steam Tables are allowed.
Candidates are requested to write their answers in their own words as far as practicable.

GROUP-A
[OBJECTIVE TYPE QUESTIONS]

2x5=10

Answer *all* questions

1. What is the Fouling factor?
2. State the function of an expansion device in a VCR system.
3. Differentiate between Primary and Secondary refrigerants.
4. Define 'Clearance Volumetric Efficiency' of a reciprocating compressor.
5. What are the suction and delivery line of a refrigeration system?

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

4x15=60

Answer any *four* questions

i) What is Evaporative Condenser? Explain with a neat sketch.

ii) A refrigerating unit of 7 tonnes capacity working on Bell-Coleman cycle has an upper limit of pressure of 6 bar. The pressure and temperature at the start of the compression are 1.0 bar and 10°C respectively. The compressed air cooled at constant pressure to a temperature of 35°C enters the expansion cylinder. Assuming both expansion and compression processes to be adiabatic with $\gamma = 1.2$; Calculate:

(i) Co-efficient of performance. (ii) Quantity of air in circulation per hour. (iii) Piston displacement of the compressor. (iv) Bore of the compressor cylinder. The unit runs at 1500 r.p.m. and is double acting. Stroke length = 650 mm. (v) Power required to drive the unit. [For air, $\gamma = 1.41$ and $C_p = 1.005$ kJ/kg K.]

i) Discuss the effect of delivery pressure, superheating of compressed vapour, and sub-cooling of liquid on the performance of a vapour compression cycle.

ii) A single stage single acting reciprocating compressor has a bore of 200 mm and a stroke of 300 mm. It receives vapour refrigerant at 1 bar and delivers it at 5.5 bar. If the compression and expansion follow the law $pV^{1.3} = \text{constant}$, and clearance volume is 5% of the stroke volume, determine the power required to drive the compressor and volumetric efficiency if it runs at 500 r.p.m.

i) How are refrigerants designated? Write down the chemical formulae for the following refrigerants:

R-11; R-170, R-717

ii) A medication room cabinet requires a cooling capacity of 80 kW. It works between a condenser temperature of 300K and an evaporator temperature of 270K. The refrigerant is sub-cooled by 5K before entering the expansion valve by the dry saturated vapour leaving the evaporator. Determine the power required to drive the compressor. The refrigerant properties are given below:

Saturation temperature (K)	Pressure (bar)	Enthalpy (kJ/kg)		Entropy (kJ/kgK)		Sp. Volume (m ³ /kg)		Sp. Heat (kJ/kgK)	
		Liquid	Vapour	Liquid	Vapour	Liquid	Vapour	Liquid	Vapour
270	2.982	154.06	1450.22	0.829	5.755	-	0.417	-	2.492
300	13.522	366.07	1488.57	1.566	5.208	1.702	0.096	4.556	2.903

i) What are the advantages of air condensers? Which factors affect the capacity of a condenser?

ii) The bore and stroke of a single-cylinder, single acting reciprocating compressor using NH₃ refrigerant are 100 mm and 80 mm, respectively. The compressor runs at 1500 r.p.m. If the condensing temperature is 30°C, and evaporator temperature is -15°C, find: a. Mass of the refrigerant circulated per minute; b. Refrigerating capacity; and c. Total power required to drive the compressor.

i) How the refrigerating capacity of a refrigerating machine can be improved?

ii) Describe the desirable properties of an ideal refrigerant.

iii) Prove that the shaft work of a reciprocating compressor per cycle neglecting clearance volume is given

by: $W_{i-f} = \frac{n}{n-1} [p_i v_i - p_f v_f]$; with all notations with usual meanings.

Properties of Saturated Ammonia:

T (°C)	P (MPa)	Specific Volume m ³ /kg		Specific Internal Energy kJ/kg		Specific Enthalpy kJ/kg		Specific Entropy kJ/kgK	
		v_f	v_g	u_f	u_g	h_f	h_g	s_f	s_g
-50	0.04084	0.001424	2.627750	118.37	1427.03	118.43	1534.34	0.5661	6.9112
-45	0.05449	0.001436	2.007080	140.23	1433.38	140.31	1542.75	0.6630	6.8100
-40	0.07169	0.001449	1.553280	162.22	1439.56	162.33	1550.92	0.7583	6.7141
-35	0.09310	0.001462	1.216780	184.34	1445.55	184.48	1558.83	0.8522	6.6232
-30	0.11943	0.001475	0.963963	206.58	1451.34	206.76	1566.47	0.9446	6.5367
-25	0.15147	0.001489	0.771672	228.94	1456.92	229.17	1573.81	1.0357	6.4543
-20	0.19008	0.001503	0.623730	251.42	1462.27	251.71	1580.83	1.1254	6.3757
-15	0.23617	0.001518	0.508679	274.01	1467.39	274.37	1587.52	1.2137	6.3005
-10	0.29071	0.001534	0.418303	296.72	1472.25	297.16	1593.86	1.3009	6.2285
-5	0.35476	0.001550	0.346635	319.54	1476.85	320.09	1599.82	1.3868	6.1593
0	0.42939	0.001566	0.289297	342.48	1481.17	343.16	1605.39	1.4716	6.0926
5	0.51575	0.001583	0.243039	365.55	1485.20	366.36	1610.55	1.5553	6.0284
10	0.61505	0.001601	0.205426	388.74	1488.92	389.72	1615.27	1.6380	5.9662
15	0.72853	0.001619	0.174614	412.06	1492.32	413.24	1619.53	1.7197	5.9060
20	0.85748	0.001639	0.149198	435.53	1495.38	436.94	1623.31	1.8005	5.8475
25	1.00324	0.001659	0.128092	459.16	1498.08	460.82	1626.59	1.8804	5.7904
30	1.16720	0.001680	0.110457	482.95	1500.40	484.91	1629.32	1.9597	5.7347
35	1.35077	0.001702	0.095633	506.93	1502.32	509.23	1631.49	2.0382	5.6802
40	1.55542	0.001726	0.083101	531.11	1503.81	533.79	1633.06	2.1161	5.6265
45	1.78266	0.001750	0.072450	555.51	1504.84	558.63	1633.99	2.1936	5.5736
50	2.03403	0.001777	0.063350	580.16	1505.37	583.77	1634.23	2.2706	5.5213
55	2.31113	0.001804	0.055538	605.09	1505.37	609.26	1633.73	2.3473	5.4693
60	2.61560	0.001834	0.048797	630.33	1504.79	635.12	1632.42	2.4239	5.4174
65	2.94913	0.001866	0.042955	655.91	1503.56	661.42	1630.24	2.5004	5.3655
70	3.31347	0.001900	0.037868	681.90	1501.62	688.20	1627.09	2.5770	5.3131
75	3.71045	0.001937	0.033419	708.34	1498.88	715.53	1622.88	2.6539	5.2601
80	4.14197	0.001978	0.029509	735.31	1495.24	743.50	1617.46	2.7312	5.2060
85	4.61002	0.002022	0.026058	762.88	1490.56	772.20	1610.69	2.8093	5.1505
90	5.11672	0.002071	0.022997	791.16	1484.67	801.76	1602.34	2.8884	5.0929
95	5.66432	0.002127	0.020268	820.29	1477.36	832.34	1592.16	2.9689	5.0328
100	6.25527	0.002190	0.017820	850.46	1468.32	864.16	1579.79	3.0513	4.9691
105	6.89227	0.002263	0.015610	881.91	1457.14	897.51	1564.72	3.1363	4.9007
110	7.57834	0.002350	0.013596	915.03	1443.19	932.84	1546.23	3.2249	4.8258
115	8.31700	0.002456	0.011740	950.47	1425.51	970.89	1523.15	3.3190	4.7418
120	9.11249	0.002594	0.009993	989.44	1402.32	1013.08	1493.38	3.4218	4.6435
125	9.97022	0.002795	0.008283	1034.97	1369.69	1062.84	1452.28	3.5417	4.5199
130	10.89770	0.003202	0.006379	1100.28	1312.96	1135.17	1382.47	3.7153	4.3287

11. In an aqua-ammonia absorption refrigeration system of 10 tonnes capacity, the vapour leaving the generator is 100% pure NH₃ saturated at 45°C. The evaporator, absorber, generator and condenser temperatures are -20°C, 30°C, 124°C and 45°C, respectively. At absorber exit, the concentration of ammonia solution is 35% with enthalpy 25 kJ/kg; and at generator exit, those values are respectively 10% and 599 kJ/kg. Determine (a) mass flow rate of ammonia in the evaporator; (b) mass flow rates of weak and strong solutions; and (c) heat rejected in the absorber, condenser and the overall C.O.P.

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GROUP-A
[OBJECTIVE TYPE QUESTIONS]

5x2=10

Answer all questions

1. Why is it important to find the natural frequency of a vibrating system? Is the frequency of a damped free vibration smaller or greater than the natural frequency of the system?
2. What is the difference between linear and nonlinear vibrations? Explain giving one example of each.
3. A harmonic motion has a frequency of 14 Hz and its maximum velocity is 6.28 m/sec. Determine its amplitude, period and maximum acceleration.
4. Will the force transmitted to the base of a spring-mounted machine decrease with the addition of damping? Explain.
5. What is meant by static and dynamic coupling? Explain with example. How the type of coupling can be established from the expressions of kinetic and potential energies of the vibrating system?

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

4x15=60

Answer any four questions

6. i) Determine the natural frequency of vibration of the system shown in Fig.1. Neglect the mass of the pulley. 6

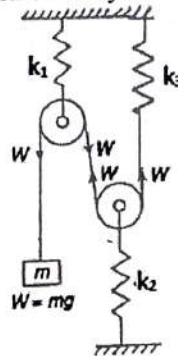


Fig.1

- ii) An electric train made up of two cars, each weighing 200 kN, is connected by couplings of stiffness equal to 3.2 MN/m, as shown in Fig.2. Determine the natural frequency of the system. 3

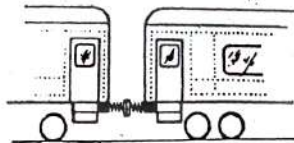


Fig.2

- iii) A rotor has a mass of 8 kg and is mounted midway on a 26 mm diameter horizontal shaft supported at the ends by two bearings which may be assumed to be simply supports. The bearings are 0.5 m apart. The shaft rotates at 2400 r.p.m. If the centre of mass of the rotor is 0.16 mm away from the geometric centre of the rotor, find the critical speed of the shaft, amplitude of the steady-state vibration and the dynamic force transmitted to the bearings. Take $E = 200 \text{ GN/m}^2$. 6

7. i) The free vibration responses of an electric motor of weight 600 N mounted on foundation is shown in Fig.3. Identify the following:
- the nature of damping provided by the foundation,
 - the spring constant and damping coefficient of the foundation, and
 - the undamped and damped natural frequencies of the electric motor.

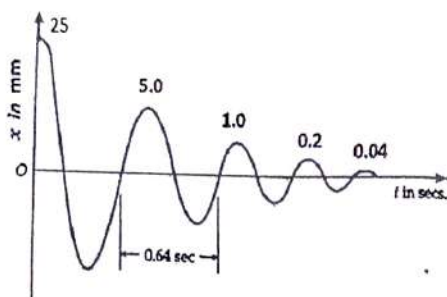


Fig.3

- Determine the natural frequency and the location of the node of torsional vibration of a shaft with two circular discs of uniform thickness at the ends. The masses of the discs are 700 kg and 1200 kg and their outer diameters are 1.4 m and 2.2 m respectively. The shaft is 4 m long and its diameter is 130 mm. Also find the ratio of amplitudes of vibrations of the two discs. Take $G = 84 \text{ GPa}$.
 - A gun is so designed that, on firing, the barrel recoils against a spring. A dashpot, at the end of recoil, allows the barrel to come back to its initial position within the minimum time without any oscillation. The gun barrel has a mass of 460 kg and a recoil spring having stiffness of 280 N/mm. The barrel recoils 0.9 m on firing. Determine
 - the initial recoil velocity of the gun barrel, and
 - the critical damping coefficient of the dashpot engaged at the end of the recoil stroke.
8. i) A machine weighs 24 kg and is supported on springs and dashpots. The total stiffness of the spring is 15 N/mm and damping is 0.28 N/mm/s. The system is initially at rest and a velocity of 120 mm/s is imparted to the mass. Determine:
- the displacement and velocity of mass as a function of time and
 - the displacement after 0.2 s.
- ii) A shaft 40 mm diameter and 3 m long has a mass of 20 kg per meter length. It is simply supported at the ends and carries two masses 120 kg and 150 kg at 0.7 m and 2.2 m respectively from the left support. Taking $E = 200 \text{ kN/mm}^2$, find the frequency of the transverse vibrations.
- iii) Determine the natural frequency of the system shown in Fig.4. The cord may be assumed inextensible in the spring-mass-pulley system and there is no slip between pulley and cord. Given $I = \frac{1}{2}mr^2$ for pulley.

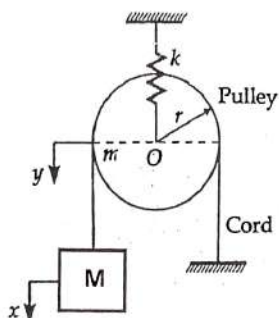


Fig.4

Determine the normal modes of vibration of an automobile simulated by the simplified 2-DOF system as shown in Fig.5 with the following numerical values:

$W=20\text{ kN}$; $l_1=1.4\text{ m}$; $l_2=1.8\text{ m}$; $k_1=40\text{ kN/m}$; $k_2=50\text{ kN/m}$; $r_g=1.4\text{ m}$ (radius of gyration about C.G.)

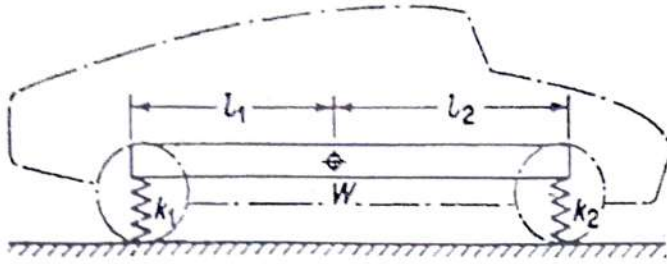


Fig.5

10. i) Determine the natural frequencies and normal modes of the system shown in Fig.6.

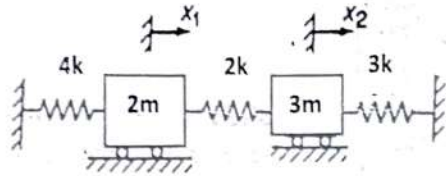


Fig.6

- ii) For the system shown in Fig.7, $W_1 = 1000\text{ N}$ and the absorber weight $W_2 = 240\text{ N}$. If W_1 is excited by a 230 N-mm unbalance rotating at 2000 rpm , determine the proper value of the absorber spring stiffness k_2 . What will be the amplitude of W_2 ?

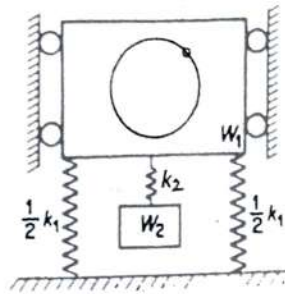


Fig.7

11. Fig.8 shows a three-mass torsional system that is unstrained to rotate freely in bearings. Write the matrix equation of motion and determine the stiffness matrix for the system. Determine the characteristic determinant, characteristic equation, natural frequencies and normal modes of the system. Draw the normal mode shapes. Given $J_1 = J$, $J_2 = 2J$, $J_3 = 3J$, $K_1 = 2K$, $K_2 = K$

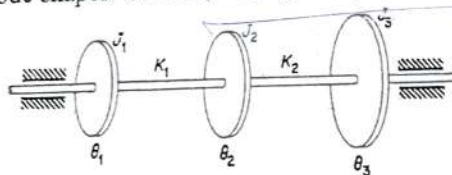


Fig.8

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2024
ECONOMICS FOR ENGINEERS

Full Marks: 70

Time: 3 Hours

The figures in the margin indicate full marks.
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GROUP-A
[OBJECTIVE TYPE QUESTIONS]

Answer *all* questions:

1. What is the declining balance method of depreciation?
2. What is recurring cost?
3. What is cash cost?
4. What is a balance sheet?
5. What is the profit volume ratio?

5x2=10

2
2
2
2
2

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

Answer any *four* questions:

6. ✓ What is economic decision-making? Write the role of engineers in the economic decision-making process. Write the steps in the economic decision-making process. What are the problems in the economic decision-making process?

4x15=60

2+4+4+5

7. Write the difference between cash cost and book cost. Write a note on classification and different elements of cost.

5+10

8. ✓ Discuss the per unit cost estimation model with mathematical examples. What is cash flow? Write the advantages and limitations of cash flow.

5+3+7

9. How the financial position of a business house can be analyzed by financial ratios? What are the ratios needed to assess the financial position of a business?

6+9

10. ✓ What is depreciation? What is the necessity of depreciation? Write a note on the factors for determining depreciation. What is the straight-line balance method of depreciation?

3+4+4+4

11. ✓ Write a note on the differences between a trading account and a profit and loss account, gross profit and net profit, trial balance and balance sheet.

5+5+5