Seth Jai Parkash Mukand Lal Institute of Engineering & Technology

Department of Mechanical Engineering

Student Handbook

Semester-VIth

January-June-2019

Bachelor of Technology (Mechanical Engineering)

SCHEME OF STUDIES/EXAMINATIONS

Semester – VI

S. No.	Course No.	Course Title	Teaching Schedule				Allotment of Marks				Duration of Exam (Hrs.)
			L	T	P	Hours/ Week	Theory	Sessional	Practical	Total	
1	ME-302N	Refrigeration and Air Conditioning	3	1	0	4	75	25	0	100	3
2	ME-304N	Tribology & Mechanical Vibration	3	1	0	4	75	25	0	100	3
3	ME-306N	Operation Research	3	1	0	4	75	25	0	100	3
4	CSE-209N	Essentials of IT	3	1	0	4	75	25	0	100	3
5	ME-308N	Computer Aided Design and Manufacturing	4	0	0	4	75	25	0	100	3
6	ME-310N	Machine Design-II	2	0	4	6	75	25	0	100	3
7	ME-312N	Refrigeration and Air Conditioning Lab	0	0	2	2	0	40	60	100	3
8	ME-314N	Tribology & Mechanical Vibration Lab	0	0	2	2	0	40	60	100	3
9	ME-316N	Computer Aided Design and Manufacturing Lab	0	0	2	2	0	40	60	100	3
		Total	**18**	**4**	**10**	**32**	**450**	**270**	**180**	**900**	

Note: *All the students have to undergo six weeks industrial training after VIth semester and it will be evaluated in VIIth semester.*

	B. Tech. VIth Semester Mechanical Engineering					
ME-302N	**REFRIGERATION AND AIR-CONDITIONING**					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time (Hrs.)**
3	**1**	**-**	**75**	**25**	**100**	**3**
Purpose	The objective of this course is to make the students aware of refrigeration, Air-conditioning, various methods of refrigeration. The course will help the students to build the fundamental concepts in order to solve engineering problems and to design HVAC applications.					
Course Outcomes						
CO 1	Understanding of different refrigeration processes like ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, steam jet refrigeration systems etc.					
CO 2	Identify, formulate and solve air refrigeration, vapour refrigeration and vapour absorption refrigeration problems.					
CO 3	Identify and understand refrigerants and their uses as per their properties and environmental effects etc.					
CO 4	Knowledge of psychometric properties, psychometric chart and its use for different cooling and heating processes along with humidification and dehumidification.					
CO 5	Design of various air-conditioning systems by including the internal and external heat gain.					

UNIT I

Basics of heat pump & refrigerator; Carnot's refrigeration and heat pump; Units of refrigeration; COP of refrigerator and heat pump; Carnot's COP; ICE refrigeration; evaporative refrigeration; refrigeration by expansion of air; refrigeration by throttling of gas; Vapour refrigeration system; steam jet refrigeration; thermoelectric cooling; adiabatic demagnetization.

Basic principles of operation of air refrigeration system, Bell-Coleman air refrigerator; advantages of using air-refrigeration in aircrafts; disadvantages of air refrigeration in comparison to other cold producing methods; simple air refrigeration in air craft; simple evaporative type air refrigeration in aircraft; necessity of cooling the aircraft.

UNIT II

Simple Vapour Compression Refrigeration System; different compression processes(wet compression, dry or dry and saturated compression, superheated compression); Limitations of vapour compression refrigeration system if used on reverse Carnot cycle; representation of theoretical and actual cycle on T-S and P-H charts; effects of operating conditions on the performance of the system; advantages of vapour compression system over air refrigeration system.

Methods of improving COP; flash chamber; flash inter cooler; optimum interstate pressure for two stage refrigeration system; single expansion and multi expansion processes; basic introduction of single load and multi load systems; Cascade systems.

Basic absorption system; COP and Maximum COP of the absorption system; actual NH_3 absorption system; functions of various components; Li-Br absorption system; selection of

refrigerant and absorbent pair in vapour absorption system; Electro refrigerator; Comparison of Compression and Absorption refrigeration systems; nomenclature of refrigerants; desirable properties of refrigerants; cold storage and ice-plants.

(b) Air-CONDITIONING

UNIT III

Difference in refrigeration and air conditioning; Psychometric properties of moist air (wet bulb, dry bulb, dew point temperature, relative and specific humidity of moist air, temperature of adiabatic saturation); empirical relation to calculate P_v in moist air.

Psychometric chart, construction and use, mixing of two air streams; sensible heating and cooling; latent heating and cooling; humidification and dehumidification; cooling with dehumidification; cooling with adiabatic humidification; heating and humidification; by-pass factor of coil; sensible heat factor; ADP of cooing coil; Air washer.

UNIT IV

Classification; factors affecting air conditioning systems; comfort air-conditioning system; winter air conditioning system; summer air- conditioning system; year round air conditioning. unitary air-conditioning system; central air conditioning system; room sensible heat factor; Grand sensible heat factor; effective room sensible heat factor.
Inside design conditions; comfort conditions; components of cooling loads; internal heat gains

from (occupancy, lighting, appliances, product and processes); system heat gain (supply air duct, A.C. fan, return air duct); external heat gain (heat gain through building, solar heat gains through outside walls and roofs); solar air temperature; solar heat gain through glass areas; heat gain due to ventilation and infiltration.
Transport air conditioning; evaporative condensers, cooling towers; heat pumps.

Text books

1. Basic Refrigeration and air-conditioning by Annanthana and Rayanan, TMG
2. Refrigeration and air-conditioning by R.C.Arora, PHI

References books

1. Refrigeration and air-conditioning by C.P arora
2. Refrigeration and air-conditioning by Arora and Domkundwar, Dhanpatrai

NOTE: In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.

LECTURE PLAN

Month	Class	Topic/Chapter Covered	Academic Activity	Test/Assignment
Jan.	6th Semester	Basics of heat pump & refrigerator; Carnot's refrigeration and heat pump	Teaching	
Jan.	6th Semester	Units of refrigeration; COP of refrigerator and heat pump	Teaching	
Jan.	6th Semester	Carnot's COP; ICE refrigeration	Teaching	
Jan.	6th Semester	Evaporative refrigeration; refrigeration by expansion of air; refrigeration by throttling of gas	Teaching	
Jan.	6th Semester	Vapour refrigeration system; steam jet refrigeration	Teaching	
Jan.	6th Semester	thermoelectric cooling; adiabatic demagnetization	Teaching	
Jan.	6th Semester	Basic principles of operation of air refrigeration system, Bell-Coleman air refrigerator	Teaching	
Jan.	6th Semester	advantages of using air-refrigeration in aircrafts; disadvantages of air refrigeration in comparison to other cold producing methods	Teaching	
Jan.	6th Semester	simple air refrigeration in air craft	Teaching	
Jan.	6th Semester	simple evaporative type air refrigeration in aircraft; necessity of cooling the aircraft	Teaching	
Jan.	6th Semester	Simple Vapour Compression Refrigeration System	Teaching	Assignment
Feb.	6th Semester	Different compression processes :wet compression	Teaching	
Feb.	6th Semester	dry or dry and saturated compression, superheated	Teaching	

		compression		
Feb.	6th Semester	Limitations of vapour compression refrigeration system if used on reverse Carnot cycle; representation of theoretical and actual cycle on T-S and P-H charts	Teaching	
Feb.	6th Semester	effects of operating conditions on the performance of the system; advantages of vapour compression system over air refrigeration system	Teaching	
Feb.	6th Semester	Methods of improving COP; flash chamber; flash inter cooler	Teaching	
Feb.	6th Semester	optimum interstate pressure for two stage refrigeration system, single expansion and multi expansion processes	Teaching	
Feb.	6th Semester	basic introduction of single load and multi load systems; Cascade systems.	Teaching	
Feb.	6th Semester	Basic absorption system; COP and Maximum COP of the absorption system; actual NH_3 absorption system; functions of various components; Li-Br absorption system	Teaching	
March	6th Semester	selection of refrigerant and absorbent pair in vapour absorption system; Electro refrigerator; Comparison of Compression and Absorption refrigeration systems;	Teaching	
March	6th Semester	nomenclature of refrigerants; desirable properties of refrigerants; cold storage and ice-plants	Teaching	
March	6th Semester	Difference in refrigeration and air-conditioning	Teaching	Assignment

March	6th Semester	; Psychometric properties of moist air :wet bulb, dry bulb, dew point temperature	Teaching	
March	6th Semester	relative and specific humidity of moist air, temperature of adiabatic-saturation; empirical relation to calculate P_v in moist air	Teaching	
March	6th Semester	Psychometric-chart, construction and use, mixing of two air streams	Teaching	
March	6th Semester	sensible heating and cooling; latent heating and cooling	Teaching	
March	6th Semester	Humidification and dehumidification; cooling with dehumidification; cooling with adiabatic humidification; heating and humidification	Teaching	
March	6th Semester	By-pass factor of coil; sensible heat factor	Teaching	
March	6th Semester	ADP of cooing coil; Air washer	Teaching	
March	6th Semester	Classification; factors affecting air conditioning systems	Teaching	Assignment
April	6th Semester	; comfort air-conditioning system	Teaching	
April	6th Semester	winter air conditioning system; summer air-conditioning system; year round air conditioning. unitary air-conditioning system; central air conditioning system	Teaching	
April	6th Semester	room sensible heat factor; Grand sensible heat factor;	Teaching	

		effective room sensible heat factor		
April	6th Semester	Inside design conditions; comfort conditions; components of cooling loads; internal heat gains from (occupancy, lighting, appliances, product and processes)	Teaching	
April	6th Semester	system heat gain (supply air duct, A.C. fan, return air duct); external heat gain (heat gain through building, solar heat gains through outside walls and roofs)	Teaching	
April	6th Semester	solar air temperature; solar heat gain through glass areas; heat gain due to ventilation and infiltration	Teaching	
April	6th Semester	Transport air conditioning; evaporative condensers,	Teaching	
May	6th Semester	cooling towers; heat pumps.	Teaching	Assignment

TUTORIAL SHEET -1

1.A carnot cycle machine works between temperatures of 7°C and 47°C. Find the thermal efficiency if the machine works as an engine and the COP's if it works as a refrigerator or as a heat pump.

2. In a Bell-Coleman Refrigeration plant, the air is drawn from cold chamber at 1 bar & 10°C & compressed to 5 bar. The same is cooled to 25°C in the cooler before expanding in the expansion cylinder to cold chamber pressure of 1 bar. Determine the theoretical net Refrigeration effect/kg. of air. The compression & expansion may be assumed as isentropic. Assume Y = 1.41, Cp = 1.00 KJ / Kg°K

Ans. RE = 95.7 KJ/Kg. of air COP = 1.71

3. An air Refrigeration system operating on an open air cycle is required to produce 25 ton Refrigeration with a cooler pressure of 12 bar & the refrigerator pressure of 1 bar. The temperature of air leaving the cooler is 25°C, the air leaving the room is at 0°C. Assume idle cycle

Determine:

a) Mass of air circulated per minute.

b) Compressor piston displacement required per minute.

c) Expander displacement required per minute.

d) COP.

e) Power required.

Ans. a) 44.65 Kg. min.

b) 35m3/min.

c) 20m3/min.

d) 0.92

e) 95.1 Kw.

4. An aircraft moving with speed of 1000 kmph uses simple air refrigeration cycle for air-conditioning. The ambient pressure and temperature are 0.35 bar and - 10^0C, respectively. The compressor pressure ratio is 4.5 Heat exchanger effectiveness is 0.95. Isentropic efficiences of compressor and expander are 0.8 each. Cabin pressure and temperature are 1.06 bar and 25^0C. Determine temperatures and pressures at all points of the cycle. Also find volume flow rate through compressor inlet and expander outlet for 100 TR and COP. CP = 1.005 KJ/Kg - R = 0.287 KJ/Kg-K and specific heat ratio for air is 1.4. [Ans.: 776m^3/min: 351.7 m^3/min : 0.2]

5.A simple evaporative air refrigeration system is used for an airplane to take 20 TR load. Ambient air is at 0.9 bar, 20^0C. The ambient air is rammed isentropically to 1 bar pressure. The air leaving the main compressor at 3.5 bar pressure is first cooled in heat exchanger having 0.6 effectiveness and then in the evaporator where its temperature is reduced by 50°C. The air from the evaporator is passed through the cooling turbine and then supplied to the cabin maintained at 1.05 bar pressure and 25^0C temperature. The internal efficiency of the compressor is 80% and that of the cooling turbine is 75%.

Determine:

(a) mass of air bled off the main compressor per minute (b) Power required for the refrigerating system (c) COP.

[Ans : 276 kg/min ; 746 KW : 0.094]

6. A regenerative air cooling system is used for an airplane to take 20 TR load. The ambient air at 0.8 bar and 10^0C is rammed isentropically to 1.2 bar. the air blend off the main compressor at 4.5 bar is cooled by the ram air in the heat exchanger whose effectiveness is 0.6. The air from the heat exchanger is further cooled to 60°C in the regenerative heat exchanger with a portion of the air bled after expansion in the cooling turbine, which gets heated to 100°C. The cabin is to be maintained at 25°C and 1 bar. The isentropic efficiencies of the compressor and turbine are 0.9 and 0.8 respectively. Find the mass of air bled from cooling turbine to be used for

regenerative cooling, power required for the refrigeration system and COP. [Ans. : 42.2 kg/min ; 30 KW ; 0.23]

7.A R -12 Refrigeration machine has saturated suction temperature of 5°C & saturated discharge temp. of 40°C. Determine :

a) Theoretical piston displacement per ton of refrigeration,

b) COP. When i) Compression is dry. ii) Compression is wet.

8. A food storage locker requires a refrigeration system of 42 ton capacity at an evaporator temperature of -5°C & condenser temp. of 40°C. The refrigerant R-12 is sub cooled 5°C before entering the expansion valve & the vapour is super heated 6°C before leaving the evaporator coil. The compression of the refrigerant is reversible adiabatic. A two cylinder 1 compressor with stroke equal to 1.5 times the bore is to be used operating at 960 RPM

Determine:

a) Refrigerating effect per Kg.

b) Mass of refrigerant to be circulated per minute.

c) Theoretical piston displacement per minute.

d) Theoretical power.

e) COP

f) Theoretical bore & stroke of compressor.

g) Heat removed through condenser per kg.

9.In a 15 TR ammonia plant, compression is carried out in two stages with water and flash intercooling and water subcooling. The particulars are: Condenser pressure 12 bar, evaporator pressure 3 bar, flash intercooler pressure 6 bar, limiting temperature for water intercooling and subcooling 20^0C. Determine the COP, power required for each compressor and swept volume of each compressor if volumetric efficiency is 0.8 in both cases. [Ans: 6.72; 3.64 KW 4.17 KW; 1.46m^3/min, 0.75m^3/min]

10. A single compressor using R-12 as refrigerant has three evaporators of capacity 30 TR, 20 TR and 10 TR. The temperatures to be maintained in the three evaporators are - 5^0C, 5C, and 10^0C. Condenser pressure is 9.6 bar. Liquid refrigerant leaving the condenser is subcooled to 30^0C. The vapours leaving the evaporators are dry and saturated. Assume isentropic compression. Determine:

a) Mass of refrigerant flowing through each evaporator.

b) Power required to drive the compressor.

c) COP.

[Ans: a) 53.12, 33.58, 16.51 kg/min b) 46.4 KW c) 4.5]

11.Air enter a dehumidifier at 30^0Cand 60% R.H. and leaves at 20^0C and 40%R.H. Calculate the amount or water drained out per hour it the air delivered from the dehumidifier is 100 cu. m. per min. Assume the atmospheric pressure to be as 1.033kg/cm^2. [ans: 73kg/hr]

12. 1,600 cu.m of air is passed per hour at a temperature of 40^0C and 60% R.H. to an air cooler and it is cooled down to a temp. of 15^0C. This cooled saturated air is passed through the coil of a water heater so as to heat it to a temperature of 24^0C. Find the final relative humidly and water drained out from the air per hour. The heater coils are supplied with water at 30^0C which leaves at 25^0C. Find the amount of water to be circulated per minute.

Ans. (35 Kg/hr, 65.5%, 13.6 Kg/min)

13. Atmosphere air at 43^0C and 75% R.H. is to be conditioned to a temperature of 25^0C and 50%. R.H. The method employed is to cool the air to dew point temperature at the conditioned state and then heat it to be the required temperature. The volume of conditioned air is 50 m^3/min. Find (i) Dew point, (ii) Weight of water drained out, (iii) Amount of heat required to raise the temp. form the dew point to that of conditioned air.

Ans. (14.1^0C, 0.3356 kg/kg, 155.9 kcal/min).

14. In an air conditioning plant 75m^3/min of outside air at 30^0C. D.B.T and 60% R.H. is mixed with 125m^3/min. of air at 15^0C. and 8^0C. W.B.T. before passing to the duct. Determine the condition of the mixture passing to the duct. Calculate the total mass and volume of the mixture passing through the duct per minute.

15.80 kg. of air per minute at 15^0C d.b temperature and having 8^0C dew point is to be conditioned by means of hot water so that its final R.H. is to be SO% and dew point is 19^0C. Find (1) the amount of vapour to be added per minute, (2) Temperature of conditioned air, (3) Amount of hot water to be circulated, if the inlet & outlet temperatures of water are 36^0C. & 32^0C. respectively & (4) Final and initial wet bulb temperatures.

Ans. (0.592 kg/min.) 2847 KJ/min, 30^0C. 22.20^0C., 170 kg/min).

16. A spray cooling coil is chosen to circulate 4,500 kg/min of chilled water for an air-conditioning plant. The inlet temperature of water is 8^0C. Air flows through the coil at a rate of 2,600 m^3/min. The air entering the cooling coil has conditions of 30^0C. d.b.t. and 50% R.H. Calculate (1) The cooling load on the coil in tons to refrigeration, (2) The temperature of chilled water leaving the cooling coil chamber, (3) The temperature of the air leaving the cooling coil chamber when its R. H. is 60% and the outlet temperature of the cooled water is 13^0C.

Ans. 629.5T, 14.97^0C., 16^0C.

17. Atmospheric air at 35^0C and 65% R.H. is to be conditioned to 15^0C and 40% R.H. The method employed is to lower the temperature to dew point of conditioned air and to raise it to the required temperature. The volume of conditioned air required is 500 m^3/min. Find (a) Dew point, (b) Weight of water drained out, and (c) amount of heat required to raise the temperature from the dew point to that of conditioned air.

Ans (a) 1.7^0C., (b) 11.78 kg/min., (c) 8345 kj.

Atmospheric air at 35^0C and 60% R.H. is to be conditioned to 22^0C and50% R.H. The method to achieve the above is firstly by cooling then dehumidifying and then heating. It the flow is 7.2 cu.m./hr., Find (1) Weight of water drained. (2) Capacity of cooling coil and (3) Capacity of heating coil.

Ans. (46.8, 17.1, 10.8 KW)

18. Air at 26^0C. and 60% R.H. is required for some industrial purpose when atmospheric conditions are 42^0C. DBT and 29^0C. WBT. The quantity of air required is500m^3/min. The required condition is achieved first by cooling and dehumidifying and then heating. If the dew point temp. of cooling coil is 10^0C then find out the following:

a) Cooling coil capacity in tons of refrigeration and its by pass factor.

b) The quantity of steam required per hour at 2 kg/cm^2 ab. and saturated which is used inheating coil. Assume only latent heat is used for heating.

c) Capacity of the eliminator.

(Ans. 96.8 tons, 0.35, 68 kg of steam/hr, 206 kg.)

19.The sensible heat load factor (SHF) of an air conditioned room is 0.65.The conditions of the air leaving the air conditioned room is 26^0C. DBT and 50% R.H. The maximum permissible temp. difference between the inlet of dehumidified air and room is 9.1^0C & required flow rate of the air is 200 cu.m/min, then find out the sensible heat load and latent heat load of the air conditioned room.

Ans. (Sensible 134,000 KJ/hr 720000 KJ/hr)

20. A space to be maintained at 28^0C DBT and 20^0C. WBT has a rate of heat gain of 21,000 Kcal/hour and a rate of moisture gain 10 Kg. per hour. Moist air enters the space at DBT of 15.5^0C. WBT is supplied for ventilation purpose at rate of 30 m^3/min. The space is to be air-conditioned. Determine (a) DBT and WBT of the air entering the cooling coil (b) tons of refrigeration required.

21. 500 kg. air is supplied per min to an auditorium at 21^0C. DBT and 40% RH The outside air is at 5^0C. DBT and 60% R.H. is passed over heating coils. It is then sprayed with water sufficient to saturate it at the dew point corresponding to the supply air. The air is finally heated to 21^0C.Find out:

a) The mass of water vapour present per kg. of dry air at the outdoor condition.
(Ans. 3.1 gm/kg.)

b) Mass of the water vapour added per kg. of air in the humidifier.

(Ans. 3.1 gm / kg.)

c) Heat supplied in the preheating coils (Ans. 4725 KJ)

d) Heat supplied in the reheating coils. (Ans. 7350 KJ)

e) Sketch the process on chart.

22.A building has the following loads:

RSH gain = 310 KW RSH gain = 100 KW The space is maintained at 25^0C DBT and 50% RH. Outdoor air is at 38^0C, 50% RH. 10% by mass of air supplied to the building is at 18^0C DBT. Find:

a) Air supplied to the space in m^3/s.

b) Volume flow rates of return air and outdoor air in m^3/s

c) State and volume flow rate of air entering the cooling coil.

d) Capacity, ADP. BPF and SHF of the cooling coil. It

[Ans. (a) 36.86 (b) 34.05, 4.01 (c) 6.3^0C DBT, 19.2^0C WBT, 38.14m^3/s (d) 591 kw, 9^0C, 0.52, 0.62J]

REFRIGERATION AND AIR-CONDITIONING

Time : 3 Hrs. **M.M. : 75**

Note: Attempt any Five questions. Use of Refrigeration tables and Psychrometric chart is permitted. Assume suitable value of any missing data.

1. (a) Efficiency of a heat engine (Carnot) working between the given source and sink is 30%. What will be Carnot COP of refrigerator and heat pump if they work between the same source &sink?

(b) The ambient air temperature during summer and winter in a particular locality are 40^0C & 15^0C respectively.

Find the values of Carnot COP for an air-conditioning system for cooling and heating corresponding to refrigeration temp. of 5^0C for summer and 55^0C for winter respectively. Take a temp. difference of 5^0C in the exchanger that exchanges heat with the surroundings.

2. A simple saturation cycle using R-22 is designed for a load of 100 TR. The saturated s suction and discharge temps. of the comp. are 5^0C and 40^0C respectively. Calculate:

   a) The mass flow rate of refrigerant.

   b) COP and isentropic horse power.

   c) The heat rejected in condenser.

3. a) State limitations of Carnot cycle with gas as the refrigerant.

b) An open air refrigeration system operating between pressures of 16 bar and 1bar is required to produce 33.5 kW refrigeration. The temperature of air leaving the refrigerated room is -5^0C and that leaving the air-cooler is 30^0C. Assume no losses & clearance. Calculate for the theoretical cycle (i) mass flow rate of air circulated (ii) Piston displacements of compressor and expander (iii) Network (iv) COP.

4. An NH_3 refrigerating plant is working at an evaporating temperature of -
30^0C and a condensing temp. of 37^0C. Capacity of the plant 150 kW. The system has multiple expansion valve with flash intercooler between the two stages of compression. Find the minimum power consumption & COP of the system.

5. a) In an absorption type refrigeration, the heat is supplied to NH_3 generator by condensing steam at 2 bar & 90% dry. The refrigeration load is 20 tons and actual COP is 70% of the maximum COP, find the mass of steam required per ton of refrigeration. Atmospheric temp. is 30^0C.

b) Discuss the role of hydrogen in three fluid vapour absorption systems.

6. a) Show that the degree of saturation (ii) and Relative Humidity (4)) of the moist air is related as where Ps is saturation pressure of.

$$\omega = \mu/1-(1-\mu)\ (P_S/P).$$

b) Derive an expression for adiabatic saturation temp. or thermodynamic WBT.

7. a) Moist air enters a chamber at 5^0C DBT & 2.5^0C WBT at a rate of 90 cmm. While passing through the chamber, the air absorbs sensible heat at the rate of 40.7 kW and picks up 40 kg/hr of saturated steam at 110^0C. Determine dry & wet bulb temp. of the leaving air.

(b) A sample of moist air has 40^0C DBT & 28^0C WBT. Calculate (i) Sp. Humidity (ii) Relative humidity (iii) Dew point temp. (iv) Density (v) Enthalpy with the help of Psychometric chart.

8. A laboratory has the following heat gains: Sensible heat = 35 kW, Latent heat = 20 kW, design conditions are Outside design conditions = 40^0C DBT, 27^0C WBT, Inside design conditions = 22^0C DBT, 50% RH. The ventilation air requirement is 80 cum. A cooling coil with a by-pass factor of 0.05 must be used. ADP of apparatus is 10^0C. Determine: (i) Amount of reheat required (ii) Supply air quantity.

REFRIGERATION AND AIR - CONDITIONING

Time :3 **Hrs.** **M. M.: 75**

Note: Attempt any FIVE questions. Use of refrigerant tables and charts are allowed. Assume the suitable value of any missing data.

1. (a) Prove that the COP of a Bell - Coleman cycle

$$COP=1/Y-1/(r)\ Y-1/Y\ -1$$

where $r = p_2/p_1$ & $Y = c_p/c_v$

(b) A dense refrigeration cycle operates between pressure of 4 bar and 16 bar. The air temperature after heat rejection to surroundings is 37^0Cand air temperature at exit of refrigerator is 7^0C. The isentropic efficiencies of turbine and compressor are 0.85 and 0.8 respectively. Determine the compressor and turbine work per TR. C.O.P and Power per TR.

Take Y = 1.4, cp = 1.0005 kJ/kg K.

2. (a) With the help of P-H diagram, show the effect on COP and refrigeration capacity of the following operating conditions :

(i) Lowering the evaporator pressure.

(ii) Increasing the condenser pressure.

(iii) Sub-cooling the liquid before entering the expansion valve.

(b) The following data refers to a 20 TR ice plant using NH_3 as refrigerant.

Temperature of NH_3 in the evaporator is -15^0C and in the condenser is 25^0C. Before entering the expansion valve NH_3 is cooled to 20^0C and NH_3 entering the compressor is dry and saturated.
Calculate for one ton of refrigeration, the power expended, COP, amount of water circulated in the condenser, if inlet and outlet temperatures of water are 20^0C and 27^0C.

3. A refrigeration system using R-12 as refrigerant consists of two evaporators of capacities 20 TR at 10^0C and 30 TR at 5^0C. The vapours leaving the evaporators are dry and saturated. The system is provided with individual compressors and multi-expansion valves. The condenser temperature is 40^0C and the liquid is subcooled to 30^0C leaving the condenser. Assume isentropic compression in each compressor. Find:
a) Mass flow rate in each compressor.
b) Power required.
c) COP of the system.

4. (a) Derive an expression for the COP of an absorption refrigeration system.

(b) With the help of neat sketch, explain the working of a modified NH_3-H_2O. vapour absorption system.

5. (a) Derive an expression for enthalpy of moist air.

(b) The atmospheric air at 30°C DBT and 75% RH enters a cooling coil at the rate of 200m^3/min. The coil dew point temperature is 14°C and the bypass factor of the coil is 10%.

Determine :

a) Temperature of air leaving the coil.

b) Capacity of cooling coil in TR.

c) Amount of water vapour removed per min.

d) Sensible heat factor of the process.

6. (a) Derive an expression for the adiabatic mixing of two air streams.

(b) 30m^3/min of moist air at 15^0C DBT and 13^0C WBT is mixed with 12 m^3/min. at 25^0C DBT and 50% RH. Determine the DBT and WBT of the resulting mixture.

7. The air-condition plant is to be designed for a small office for winter air-conditioning:-

Outdoor conditions 10^0C DBT & 8^0C WBT. Required indoor conditions 20^0C DBT & 60% RH. Amount of air circulation $3m^3$/min/person. Seating capacity of the office 50 persons. The required condition is achieved first by heating and then by adiabatic humidifying. Find:

(a) Heating capacity of the coil in kW and the surface temperature. if the by pass factor of the coil is 0.32.

(b) Capacity of humidifier in kg per hr.

8. Attempt any Three of the following :

a) Aircraft cooling by simple evaporative cooling system

b) Electrolux

c) Properties of refrigerant

d) Steam jet refrigeration.

BT-6 / M-17

REFRIGERATION AND AIR- CONDITIONING

Paper—ME-302E

Time allowed : 3 hours **Maximum marks : 100**

Note : Attempt FIVE questions, selecting one question from each unit.

Unit- I

1. (a) A refrigerating system operates on the reversed Carrot cycle between the temperatures limits of 15°C and -10°C. The capacity is to be 8 TR. Determine:

i) Co-efficient of performance.

ii) Power rating of the compressor motor if the overall electro-mechanical efficiency is 85%.

iii) Heat rejected from the system per minute. 12

(b) Describe the steam jet refrigeration system with neat diagram. 8

2. An air refrigerator works between the pressure limits of 1 bar and 5 bar, The temperature of air entering the compressor and expansion cylinder are 10°C and 25°C respectively. The expansion and compression follow the law $pv^{1.3}$= constant. Find the following

i) The theoretical COP of the refrigerating cycle.

ii) If the load on the refrigerating machine is 10 TR, find the amount of air circulated through the system assuming that the actual COP is 50% of the theoretical COP.

Unit--II

3.A single compressor using R-12 as refrigerant has three evaporators of capacity 10TR, 20 TR and 30TR. All the evaporators operate at --10°C and the vapour leaving the evaporator are dry and saturated. The condenser temperature is 40°C and liquid refrigerant is sub cooled to 30°C. Assume isentropic compression in the compressor. Find

i) Mass of refrigerant flowing in each evaporator.

ii) Power required to drive the compressor.

iii) COP of the system.

iv) Draw the layout and P-H diagram of the system. 20

4. i) What is the function of flash intercooler provided in a compound vapour compression refrigeration system? 8

ii) Draw a neat sketch of Electrolux refrigerator and explain its working principle. What is the important role of hydrogen in this system? 1 2

Unit-III

5. (a) 800 m3/min of recirculated air at 22°C DBT and 10°C dew point temperature is to be mixed with 300m3hnin of fresh air at 30°C DBT and 50% RH. Determine the enthalpy, specific volume, humidity ration and dew point temperature of the mixture. 13

b) Derive the following relation. 7

6. The air conditioning plant is to be designed for a small office for winter air conditioning :

Outdoor conditions are 10°C DBT & 8°C WBT. Required indoor conditions are 20°C DBT & 60% RH. Amount of air circulation 0.3m^3/min/person. Seating capacity of the office 50 persons.

The required condition is achieved first by heating and then adiabatic humidifying. Find:

(a) Heating capacity of coil in KW and the surface temperature, if the by-pass factor of the coil is 0.32.

(b) Capacity of the humidifier in kg per hr. 20

Unit- IV

7. The following data relate to an air-conditioned space :

i) outdoor conditions…….38°C DBT, 50% RH.

ii) indoor conditions……...24°C DBT, 50%RH.

iii) sensible heat load……..24 KW.

iv) latent heat load……..6 KW.

v) by pass factor of cooling coil……..0.16.

If the ventilation requirement is such that on mass flow rate basis 20 percent of fresh air is introduce and 80 percent of the supply air is recirculated, determine :

i) supply air flow rate.

ii) outside air sensible heat.

iii) Outside air latent heat.

iv) Grand total heat.

v) Effective room sensible heat.
20

8. (a) Describe the transport air conditioning in detail.
10

(b) Differentiate between the unitary and central air- conditioning unit.

Roll No.

PrintedPages: 3

BT: 6/M-18

REFRIGERATION AND AIR-CONDITIOMNG

Paper-ME-302 N

Time allowed: 3 hours] [Maximum marks: 75

Note: - Attempt only five questions, selecting one question from, each unit. Assume missing data if any. Students can use refrigeration charts and table to solve numerical problems.

Unit-I

1. The cock pit of a jet plane flying at a speed of 1200 km/h is to be cooled by a simple air cooling system. The cock pit is to be maintained at 25^{o}C and the pressure in the cockpit is I bar. The ambient air pressure and temperature are 035 bar and 30^{o}C. The other data available is as follows: Cock pit cooling load: 10 TR; Main compressor pressure ratio: 4; Ram efficiency: 90%; Temperature of air leaving the heat exchanger and entering the cooling turbine: 60^{o}C; Pressure drop in the heat exchanger: 0.5bar; Pressure drop between cooler turbine and cock-pit: 0.2bar. Assuming the isentropic efficiencies of main compressor and cooler turbine as 80%, find the quantity of air passed through the cooling turbine and C.O.P of the system. Take y: 1.4 and Cp: l Kj/kg K 15

2. (a) Explain the open and dense Bell Coleman cycle. Derive the expression for COP when the compression and expansion process follows the pv^{n}: constant. 10

(b) Describe the adiabatic demagnetization. 5

Unit-II

3. Calculate the power required to compress 18 kg/min of NH, from saturated vapour at I.4 bar to condensing pressure of; 10 bar by a two stage compression with flash inter cooling by liquid Refrigerant at 4 bar. Assume the refrigerant leaves evaporator as saturated vapour and leaves condenser as saturated liquid. Also find out the load in evaporator in tonnes of refrigeration Calculate power required without multi-staging. 15

4. (a) Draw a neat diagram of Electrolux refrigerator and explain its working principle. What is the important role of hydrogen in this system? 10

(b) State the advantages of vapour absorption over the vapour compression refrigeration system. 5

Unit-III

5. The air conditioning plant is to be designed for a small office for winter air-conditioning. The Outdoor conditions are 10^{o}C DBT & 8^{o}C WBT. Required indoor conditions are 20^{o}C DBT and 60% RH. Amount of air circulation $0.3m^{3}$ / min/ person. Seating capacity of the office 50 persons. The required condition is achieved first by heating and then adiabatic humidifying. Find:

(a) Heating capacity of coil in KW and the surface temperature, if the by- pass factor of the coil is 0.32

(b) Capacity of the humidifier in kg per hr. 15

6. Atmospheric air at a l6^{o}C DBT and 25% RH passes through a furnace and then through a humidifier in such a way that the final DBT is 30^{o}C and 50% RH. Determine: (i) heat and moisture added to air. (ii) Sensible heat factor of the process. 15

Unit-IV

7. An air conditioned auditorium is to be maintained at27^{o}C DBT and 55% RH. The ambient condition is 39^{o}C DBT and 28^{o}C WBT. The total sensible heat load is 120000 kJ/ h and the total Latent heat load is 45000 kJ/ h. 60% of retuned

air is re-circulated and mixed with 40 % of make-up air after the cooling coil. The condition of air leaving the cooling coil is 17^{o}C. Determine:

(a) Room sensible heat factor

(b) Condition of air entering the auditorium.

(c) Amount of make-up air

(d) Apparatus dew point

(e) By- pass factor of the cooling coil

8. (a) Describe the transport air conditioning in detail. 7

(b) Differentiate between the unitary and central air- conditioning 8

	B. Tech. VIth Semester Mechanical Engineering					
ME-304N	**Tribology & Mechanical Vibration**					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time (Hrs.)**
3	**1**	**0**	**75**	**25**	**100**	**3**
Purpose:	To understand the vibration systems with different degrees of freedom in different modes and conditions and the basics of tribology.					
Course Outcomes						
CO 1	To understand the fundamentals of vibrations and study the systems in single D.O.F. under free and damped vibrations.					
CO 2	To study and analyze the different types of forced vibration system in single D.O.F.					
CO 3	To understand the concept of principle modes of vibrations using different methods and study lateral, longitudinal and torsional vibration in case of beams, bars and shafts respectively.					
CO 4	To understand the fundamentals of tribology of lubrication, friction and wear.					

UNIT I

Fundamentals of Vibration: Elements of a vibratory system, S.H.M., degrees of freedom, Types of vibrations, Work done by a harmonic force, Beats. **Undamped free vibrations:** Natural frequency by equilibrium and energy methods, equivalent spring, linear and torsional systems, compound pendulum, Bifilar and Trifilar suspensions.

Damped free vibrations: Different types of damping, differential equations of damped free vibrations, initial conditions, logarithmic decrement, vibrational energy and logarithmic decrement.

UNIT II

Single Degree of Freedom Systems- Forced Vibrations: Sources of excitation**,** equations of motion with harmonic force, response of rotating and reciprocating unbalanced system, Support motion, Vibration Isolation, Force and Motion transmissibility.

Forced vibrations with coloumb damping, structural damping and viscous dampings.

UNIT III

Multi-degree of freedom systems: Principle modes of vibrations, Influence co-efficient, Matrix method, orthogonality principle, Dunkerleys equation, Matrix iteration method, Holzer Method, Rayleigh Method and Rayleigh-Ritz methods, Stodola method, Hamilton principle.

Continuous systems: Transverse vibrations of strings, Longitudinal Vibrations of bars, Lateral vibration of beams, Torsional vibration of circular shafts.

UNIT IV

Introduction to Tribology, Tribology in design, Tribology in industry, economic aspects of Tribology, **Lubrication:** Basic modes of lubrication, lubricants, properties of lubricants -

physical and chemical, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, disposal of scrap oil, oil emulsion.

Friction and Wear: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation. Introduction to Wear, Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.

Text Books:

1. Grover G. K. "Mechanical Vibrations", Nem Chand and Bros.,Roorkee
2. Meirovitch, "Elements of Mechanical Vibrations", McGraw Hill
3. J.S.Rao and K.Gupta, 'Introductory course on theory and practice of Mechanical Vibration, New Age International.
4. Friction and wear of Materials- By E. Robinowicz, Johan Wiley
5. Tribology an Introduction - By Sushil Kumar Srivastava
6. B. C. Majumdar, "Introduction to Tribology and Bearings", S.Chand and Company Ltd. New Delhi.

Reference Books:

1. Rao S. S. "Mechanical Vibrations", Pearson Education Inc. Dorling Kindersley (India) Pvt. Ltd. New Delhi.
2. V.P. Singh, "Mechanical Vibrations", Dhanpat Rai & Co. Pvt. Ltd., Delhi
3. Prashant Sahoo, ''Engineering Tribology'', PHI publications.
4. Halling J., "Principles of Tribology", McMillan Press Ltd.

Lecture Plan
Tribology & Mechanical Vibration
ME-304N

Month	Class	Topic/Chapter Covered	Academic Activity	Test/Assignment
Jan.	6th Semester	Elements of a vibratory system, S.H.M., degrees of freedom, Types of vibrations	Teaching	
Jan.	6th Semester	Work done by a harmonic force, Beats	Teaching	
Jan.	6th Semester	Natural frequency by equilibrium and energy methods, equivalent spring, linear and torsional systems, compound pendulum	Teaching	
Jan.	6th Semester	Natural frequency by equilibrium and energy methods, equivalent spring, linear and torsional systems, compound pendulum	Teaching	

Jan.	6th Semester	Bifilar suspensions	Teaching	
Jan.	6th Semester	Trifilar suspensions	Teaching	
Jan.	6th Semester	Different types of damping	Teaching	
Jan.	6th Semester	Differential equations of damped free vibrations, initial conditions,	Teaching	
Jan.	6th Semester	Logarithmic decrement	Teaching	
Jan.	6th Semester	Vibrational energy and logarithmic decrement.	Teaching	
Jan.	6th Semester	Sources of excitation**,** equations of motion with harmonic force	Teaching	Assignment
Feb.	6th Semester	response of rotating and reciprocating unbalanced system	Teaching	
Feb.	6th Semester	Support motion	Teaching	
Feb.	6th Semester	Vibration Isolation	Teaching	
Feb.	6th Semester	Force and Motion transmissibility	Teaching	
Feb.	6th Semester	Principle modes of vibrations	Teaching	
Feb.	6th Semester	Influence co-efficient	Teaching	
Feb.	6th Semester	Matrix method	Teaching	
Feb.	6th Semester	Orthogonality principle	Teaching	Assignment
March	6th Semester	Dunkerleys equation	Teaching	
March	6th Semester	Matrix iteration method	Teaching	
March	6th Semester	Holzer Method	Teaching	
March	6th Semester	Rayleigh Method	Teaching	
March	6th Semester	Rayleigh-Ritz methods	Teaching	
March	6th	Stodola method	Teaching	

	Semester			
March	6th Semester	Hamilton principle	Teaching	
March	6th Semester	Transverse vibrations of strings	Teaching	
March	6th Semester	Longitudinal Vibrations of bars	Teaching	
March	6th Semester	Lateral vibration of beams	Teaching	
March	6th Semester	Torsional vibration of circular shafts.	Teaching	Assignment
April	6th Semester	Introduction to Tribology, Tribology in design, Tribology in industry, economic aspects of Tribology	Teaching	
April	6th Semester	Basic modes of lubrication, properties of lubricants - physical and chemical, types of additives	Teaching	
April	6th Semester	extreme pressure lubricants, recycling of used oils and oil conservation	Teaching	
April	6th Semester	Introduction, laws of friction, kinds of friction, causes of friction, friction measurement	Teaching	
April	6th Semester	Theories of friction, effect of surface preparation. Introduction to Wear, Types of wear	Teaching	
April	6th Semester	Various factors affecting wear, measurement of wear	Teaching	
April	6th Semester	Wear between solids and liquids, theories of wear	Teaching	Assignment

Tutorial Sheet-I

1.(a) Explain Frahm vibration absorber.

(b) Write short note on Frequency measuring instrument.

2. Find the lowest natural frequency of the system shown in Fig.1 using Rayleigh method.

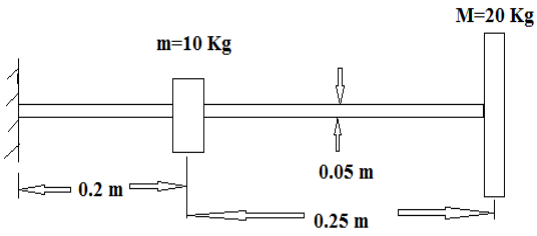


Fig. 1

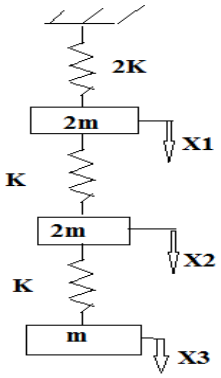


Fig.2

3. Find the lowest natural frequency of system shown in fig.2 by matrix Iteration method.

4. Derive differential equation of undamped free vibration of single degree of freedom system.

5. A light cantilever with length 1m , inertia 300 mm^4, mass attached to free end 10 Kg and modulus of elasticity 500 N/mm^2 is under undamped free vibration. Find natural frequency of system considering single degree of freedom system.

6. Explain fluid dash pot system.

7. A spring mass system having two springs and damper in series has free vibration.
The stiffness and damping co-efficient are 3000,1200,100,330 respectively. The mass is 10 Kg. Find natural frequency.

8. The damped natural frequency of a system as obtained from free vibration is 9.8 Hz. During the forced vibration test constant exciting force on the same system the maximum amplitude of vibration is found to be at 9.6 Hz. Find the damping factor of system and natural frequency.

9. A body is subjected to the two harmonic motion as:

$X = 15\sin(\omega t + \pi/6)$ $X_2 = 8\cos(\omega t + \pi/3)$ What extra motion should be given to the body bring it to the state of equilibrium ?

10. Split up the harmonic motion $X = 10\sin(\omega t + \pi/6)$ into two harmonic motions one having a

phase angle of zero & the other 46^0.

Tutorial Sheet-II

1. Derive equation of motion of damped free vibration of single degree of freedom system with free body diagram.

2. Explain eddy current damping of vibration

3. Derive the expression for equation of motion of simple pendulum with undamped natural frequency.

4. Derive an expression for vibration absorber.

5. Write short note on Frequency measuring instrument.

6. Find the lowest natural frequency of the system shown in Fig.1 using Rayleigh method.
E= 2.1×10^{11} N/m^2

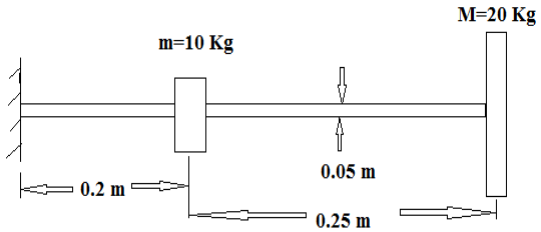


Fig. 1

7.(a) Explain the method of vector representation of harmonic motion.
(b) Find the natural frequency of torsional oscillation for the system shown in Fig. (2). Take G= 0.83×10^{11} N/m^2 .

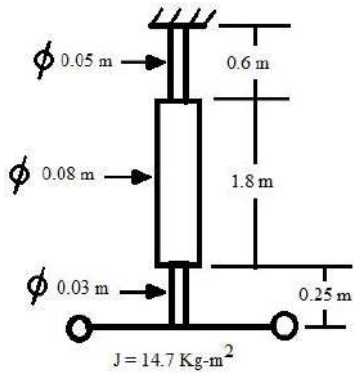


Fig. (2)

8. Add the following vectors analytically $X_1 = 4\ \text{Cos}\ (\omega t+10^0)$, $X_2 = 6\text{Sin}\ (\omega t+60^0)$ Check the solution graphically.

9. The displacement of the slider in the slider crank mechanisism is given by:

   X = 24 Cos πt + 3/2 Cos πt Plot a displacement versus time diagram. What is the acceleration of the piston at t = 1/8 sec.

10. A mass of 10 Kg. When suspended from a spring, causes a static deflection of 1 cm. Find the natural frequency of the system.

Tutorial Sheet-III

1. A single cylinder vertical petrol engine of total mass 320 kg is mounted upon a steel chassis frame and causes a vertical static deflection of 0.2 cm. The reciprocating parts of the engine have a mass of 24 kg and move through a vertical stroke of 15 cm with S.H.M. A dashpot is provided, the damping resistance of which is directly proportional to the velocity and amounts to 490 N at 0.3 m/sec Determine

(i) the speed of the driving shaft at which resonance will occur, and
(ii) the amplitude of steady state forced vibrations when the driving shaft of the engine rotates at 480 r.p.m.

2. The springs of an automobile trailer are compressed 0.1 m under its own weight. Find the critical speed when the trailer is travelling over a road with a profile approximated by a sine wave of amplitude 0.08 m and wave length of 14 meters. What will be the amplitude of vibration at 60 km/hour.

3.Explain any three vibration measuring instruments.

4. Determine the natural frequency of torsional vibrations of a shaft with two circular discs of uniform thickness at the ends, as shown in Fig.1. The masses of the discs are M1 = 500 kg and M2=1000 kg and their outer diameters are D1 = 125 cm and D2 = 190 cm. The length of shaft is L = 300 cm and its diameter d = 10 cm. Modulus of rigidity for the material of the shaft is G = 0.83 x 1011 N/m2.
Also find in what proportion will the natural frequency of this shaft change if along half length of the shaft the diameter is increased from 10 cm to 20 cm.

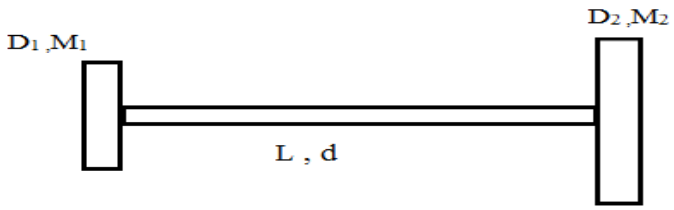


Fig.1

5. A three degree of freedom system is schematically shown in Fig.2 Write down three differential equations of motion by Newton's Second Law. Put these equations in matrix form.

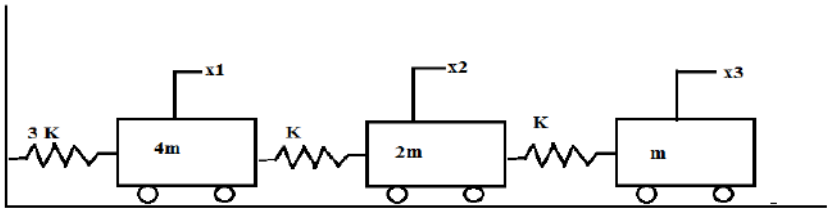


Fig.2

6.Explain influence coefficient and Maxwell's reciprocal theorem.

7. Explain Rayleigh method.

8. A spring-mass dashpot system consists of a spring of stiffness 343 N/m. The mass is 3.43 kg. The mass is displaced 2 cm beyond the equilibrium position & released. Find the equation of motion for the system, if the damping coefficient of the dashpot is equal to:

   (i) 137.2 N - Sec/m ii) 68.6 N - Sec/m

9. Two dasphots of coefficient Cl & C2 are connected in (i) Series(ii)Parallel Find their equivalent damping coefficients from first principles.

10. Show that the max velocity of vibration of the mass of a spring mass dashpot system occurs at (w/wn) = 1 irrespective of the amount of damping.

Tutorial Sheet-IV

1. Find the fundamental natural frequency of transverse vibration for the system shown in Fig.1 by Dunkerley's method. E = 1.96×1011 N/m^2, I = 4×10^{-7} m^4

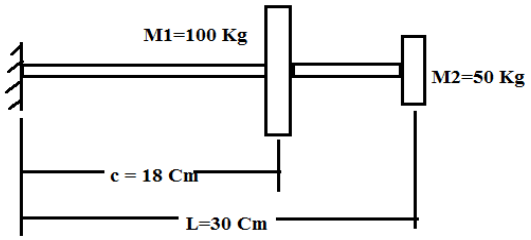


Fig.1

2. A rotor having a mass of 5 kg, is mounted midway on a 1 cm dia shaft supported at the ends by two bearings. The bearing span is 40 cm. Because of certain manufacturing inaccuracies, the C. G. of the disc is 0.02 mm away from the geometric centre of the rotor. If the system rotates at 3000 r.p.m. find the amplitude of steady state vibrations and the dynamic force transmitted to the bearings. Neglect damping. Take E =1.96 x 10^{11} N/m^2.

3. Write short notes on critical speed of shaft and laplace transformation.

4.Determine the differential equation of motion for the system shown in Fig.2,where the moment of inertia of the mass M and the bell crank lever about O is J_0 . What is the time period of vibration of this system in the vertical plane ? Is there any limitation in the value of b ?

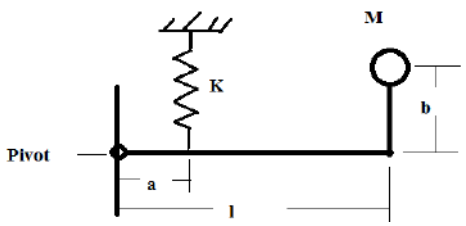


Fig.2

5.Calculate the natural frequency of vibration of a torsional pendulum as shown in Fig.3 with the following dimensions. Length of rod ,L=1m , Diameter of rod, d=5mm, Diameter of rotor, D=0.2m , Mass of rotor, M=2Kg.

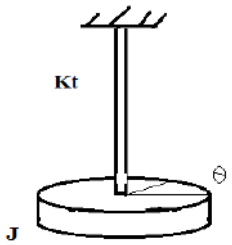


Fig.3

6. A horizontal spring mass system with coulomb damping has a mass of 5 Kg attached to a spring of stiffness 980 N/m. If the coefficient of friction is 0.025, calculate
(i) the frequency of oscillation
(ii) the number of cycles corresponding to 50% reduction in amplitude if the initial amplitude is 5 cm
(iii) the time taken to achieve this 50% reduction

7. The springs of an automobile trailer are compressed 0.1 m under its own weight. Find the critical speed when the trailer is travelling over a road with a profile approximated by a sine wave of amplitude 0.08 m and wave length of 14 meters. What will be the amplitude of vibration at 60 km/hour.

8. Derive an expression for Forced Vibrations with Constant harmonic Excitation.

9. Derive an expression for Principal mode of Vibration for a spring mass system. And also apply these eqns on a case of two masses fixed on a tightly stretched string. Explain in detail about various type of Vibration absorbers.

10. Derive an expression for Frahm Vibration Absorber.

BT / M-17

MECHANICAL VIBRATIONS

Paper-ME-306E

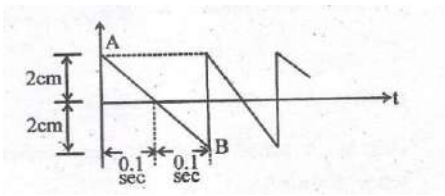
Time allowed : 3 hours Maximum marks : 100

Note: Attempt any five questions taking at least one, question from each unit.

Unit-I

1.(a) Represent the Periodic motions given in fig. by Harmonic motion. 15

(b) Explain Degree of freedom in short 5



The rectilinear motion of a point is given by α=-9x, where a. and x are the acceleration and displacement of simple harmonic motion and the amplitude is 2 inch. Find

(i) The period and frequency

(ii) Displacement velocity and acceleration. After 21.5 seconds.

Unit-II

A vibrating system is defined by the following parameters: m = 3 kg ; k = 100N/m, C= 3 N sec/m. Determine :

{i) The damping factor

(ii) Natural frequency of damped vibrations

(iii) Logarithmic decrement

(iv) Ratio of two successive amplitudes

(v) The number of cycles after which the original amplitudes is reduced to 20%. 20

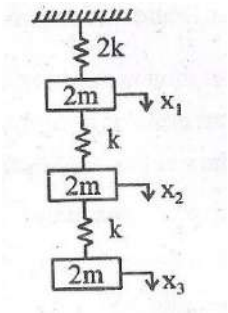
(vi)

4. Define and explain vibration absorber. (20)

Unit-III

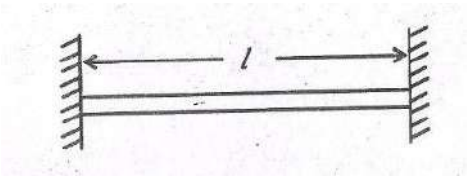
5. Explain Reyleigh Method in detail. (20)

6. Using Matrix Method determine the natural frequencies of the system shown in figure. (20)

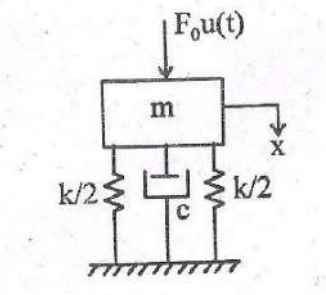


Unit-IV

7. A bar of uniform cross section having length I is fixed at both ends as shown in fig. The bar is subjected to longitudinal vibrations having a constant velocity V_0 at all points Derive expression of longitudinal vibration in the bar. (20)



8. A spring mass system is shown in fig. If the system is initially relaxed and a step function excitation is applied to the mass find the response of the system. (20)



BT6 / M-18
TRIBOLOGYAND MECHAMCALVIBRATION
Paper-ME-304N Opt. IK

Time allowed: 3 hours Maximum Marks : 75

Note:.Attempt five questions in all, selecting atleast one question from each unit. All questions carry equal marks.

Unit-I

l.(a)Differentiate between linear and non-linear vibrations, deterministic and non-deterministic vibrations,free and forced vibrations. (7)

(b)Explain the graphical method for the addition of two simple harmonic motions. (8)

2. (a) The natrnal frequency of a spring mass system is 15 Hz. An extra 3 kg of mass is coupled to its mass and natural frequency reduced by 3Hz.Find the mass and stiflness of the system.(10)

(b) Explain the overdamped and criticatly damped system. (5)

Unit-II

3. A machine having a mass of 100 kg and supported on a spring of total stiffness k = 7.84×105 has an unbalanced rotating element which results in a disturbing force of 392N at a speed of 3000 rpm.Assuming damping factor= 0.20,determine: (15)

(a) Amplitude of motion due to unbalance.
(b) The transmissibility
(e) The transmitted force.

4. An aircraft instrument of mass 10 kg is to be isolated from the engine vibrations. The engine runs at speeds ranging from 1800 rpm to 2500 rpm. Natural rubber isolators with negligible damping is used. Determine the rubber stiffness for 90% isolation. (15)

Unit-III

5. Using matrix iteration method determine the first two natural frequencies and the mode shapes of the system shown in Fig. 1. (15)

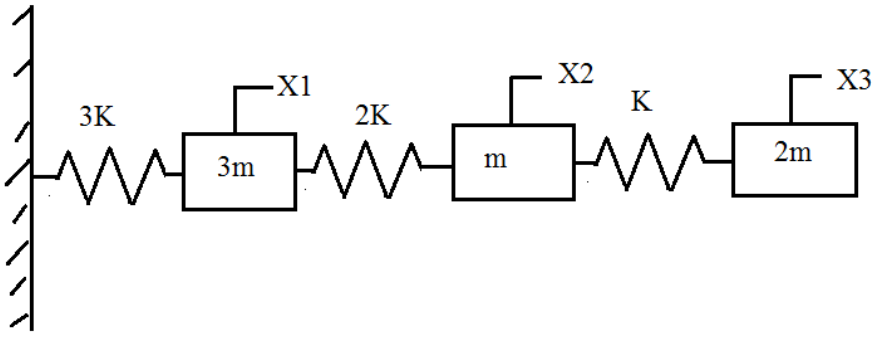


Fig.1

6. Derive the frequency equation of longitudinal vibrations for a free-free beam with zero initial displacement. (15)

Unit-IV

7. Define Wear. What are the different types of wear? What are the various factors affecting wear? What methods are used for the meastrement of wear?15

8. What are the basic modes of lubrication? List various physical and chemical properties of lubricants. What are the various types of additives used in lubrication techniques. (15)

	B. Tech. VIth Semester Mechanical Engineering					
ME-306N	**OPERATION RESEARCH**					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time (Hrs.)**
3	**1**	**-**	**75**	**25**	**100**	**3**
Purpose	To make the students aware of various optimization techniques used for solving engineering problems.					
Course Outcomes						
CO1	To study necessity, applications, scope related to industry. To make the students aware of linear programming and its graphical representation.					
CO 2	To minimize the transportation cost using transportation models. To discuss and understand the network analysis representations.					
CO 3	To understand simulation. Its applications, merits and demerits. Furthermore, waiting line theory and decision theory are also helpful to solve various engineering problems.					
CO 4	Solve the problems related to Queuing theory and game theory.					

UNIT 1

Introduction: Definition and Development of Operations Research, Necessity and scope of OR in Industry, Operations Research in Decision making, Models in OR, Fields of application, Difficulties and Limitation of OR.

General Linear Programming Problems: Introduction, Maximization and minimization of function with or without Constraints, Formulation of a linear programming problem, Graphical method and Simplex method, Big M method, Degeneracy, Application of linear Programming (LPP) in Mechanical Engineering.

UNIT 2

The Transportation Problems: Mathematical formulation, Stepping stone method, Modified Distribution Method, Vogels Approximation Method, Solution of balanced and unbalanced transportation problems and case of degeneracy, Assignment problems, Least time transportation problem

Network Analysis: CPM/PERT, Network Representation, Techniques for drawing network, Numbering of events (Fulkersen Rule), PERT calculations - Forward path, back-ward path, Slack, probability, comparison with PERT, Critical path, Float, Project cost, Crashing the net work, updating (PERT and CPM).

UNIT 3

Simulation: Basic concept of simulation, Applications of simulation, Merits and demerits of simulation, Monte Carlo simulation, Simulation of Inventory system, Simulation of Queuing system.

Waiting Line Theory: Basic queuing process, Basic structure of queuing models, some commonly known queuing situations, Kendall's notation, Solution to M/M/1: ∞ /FCFS models.

Decision Theory: Steps in decision theory approach, Decision Machinery environment, Decision machining under certainty and uncertainty, Decision machining under condition of risk, Decision trees, Minimum enchained criteria, Advantages and limitations of decision tree solutions, Post Optimality.

Unit 4

Queuing Theory: Introduction, Applications of queuing Theory, Waiting time and idle time costs, Single channel queuing theory and multi-channel queuing theory with Poisson arrivals and exponential services, Numerical on single channel and multi channel queuing theory.

Game Theory: Theory of games, competitive games, Rules and Terminology in game Theory, Rules for game theory- saddle point, dominance, Mixed strategy (2 x2 games) , Mixed strategy (2 x n games or m x 2 games), Mixed strategy (3 x3 games),Two person zero sum games, N-person zero sum games.

Text books

1. Operations Research by Prem Kumar Gupta and D. S. Heera, S. Chand Publications
2. Introduction to Operations Research, by F.S. Hillier and G.J. Lieberman, seventh edition, McGraw Hill publications

Reference Books:

1. Introduction to Mathematical Programming by Winston, W.L. (4th ed.), Duxbury Press.
2. Operations Research by P Sankara Iyer, Mc Graw Hill publications.

NOTE: In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.

Lecture Plan

OPERATION RESEARCH

ME-306N

Month	Class	Topic/Chapter Covered	Academic Activity	Test/Assignment
Jan.	6th Semester	**Introduction:** Definition and Development of Operations Research .	Teaching	
Jan.	6th Semester	Necessity and scope of OR in Industry, Operations Research in Decision making	Teaching	
Jan.	6th Semester	Models in OR, Fields of application, Difficulties and Limitation of OR.	Teaching	
Jan.	6th Semester	**General Linear Programming Problems**: Introduction,	Teaching	
Jan.	6th Semester	Maximization and minimization of function with or without Constraints	Teaching	
Jan.	6th Semester	Formulation of a linear programming problem, Graphical method and Simplex method	Teaching	
Jan.	6th Semester	Big M method, Degeneracy, Application of linear Programming (LPP) in Mechanical Engineering	Teaching	
Jan.	6th Semester	**The Transportation Problems:** Mathematical formulation,	Teaching	Assignment
Jan.	6th Semester	Stepping stone method	Teaching	
Jan.	6th Semester	Modified Distribution Method, Vogels Approximation Method	Teaching	
Jan.	6th Semester	Solution of balanced and unbalanced transportation problems and case of degeneracy,	Teaching	
Feb.	6th Semester	Assignment problems, Least time transportation problem	Teaching	Assignment

Feb.	6th Semester	**Network Analysis:** CPM/PERT, Network Representation, Techniques for drawing network,	Teaching	
Feb.	6th Semester	Numbering of events L: Fulkersen Rule, PERT calculations - Forward path,.	Teaching	
Feb.	6th Semester	back-ward path, Slack, probability, comparison with PERT, Critical path,	Teaching	
Feb.	6th Semester	Float, Project cost, Crashing the network,	Teaching	
Feb.	6th Semester	updating (PERT and CPM)	Teaching	Assignment
Feb.	6th Semester	**Simulation**: Basic concept of simulation, Applications of simulation, Merits and demerits of simulation,	Teaching	
Feb.	6th Semester	Monte Carlo simulation, Simulation of Inventory system, Simulation of Queuing system.	Teaching	
March	6th Semester	**Waiting Line Theory**: Basic queuing process, Basic structure of queuing models,	Teaching	
March	6th Semester	some commonly known queuing situations, Kendall's notation, Solution to M/M/1: ∞ /FCFS models.	Teaching	
March	6th Semester	**Decision Theory:** Steps in decision theory approach, Decision Machinery environment,	Teaching	
March	6th Semester	Decision machining under certainty and uncertainty, Decision machining under condition of risk,	Teaching	
March	6th Semester	Decision trees, Minimum enchained criteria,	Teaching	
March	6th Semester	Advantages and limitations of decision tree solutions,	Teaching	

March	6th Semester	Post Optimality.	Teaching	Assignment
March	6th Semester	**Queuing Theory**: Introduction, Applications of queuing Theory	Teaching	
March	6th Semester	Waiting time and idle time costs, Single channel queuing theory	Teaching	
March	6th Semester	multi-channel queuing theory with Poisson arrivals	Teaching	
March	6th Semester	Exponential services, Numerical on single channel and multi channel queuing theory.	Teaching	
April	6th Semester	**Game Theory**: Theory of games	Teaching	
April	6th Semester	competitive games, Rules and Terminology in game Theory	Teaching	
April	6th Semester	Rules for game theory- saddle point, dominance, Mixed strategy (2 x2 games)	Teaching	
April	6th Semester	Mixed strategy (2 x n games or m x 2 games)	Teaching	
April	6th Semester	Mixed strategy (3 x3 games)	Teaching	
April	6th Semester	Two person zero sum games,	Teaching	
April	6th Semester	N-person zero sum games	Teaching	Assignment

TUTE SHEET NO. 1

Que. 1 Define Operation research and describe its applications.
Que 2 Discuss the significance and scope of operation research in modern management.
Que 3 System approach is an important characteristic of OR comment. Discuss other characteristics of OR.
Que 4 Model building is a central element in OR methods. Give a description of all basic type of models.
Que 5 Reduce the following L.P. problem to the standard from:

Determine $x \geq 0$, so as to minimize $G = 2x + y + z$
Subject to $-5x + 2y \leq 5$, $3x + 2y + 4z \geq 7$, $2x + 5z \leq 3$

TUTE SHEET NO. 2

Que 1 maximize $Z = 4x + 5y + 2z$
Subject to ; $2x+y+z < 10$; $x+3y+z \leq 12$; $x+y+z = 6$ where $x,y,z > 0$
Use Big-M method to solve
Que2 What is unbalanced T.P.? How to solve it ? Solve the following problem by a) Vogel method b) Least Cost method
Que 3 Explain PERT and its importance in network analysis.
Que 4 Compare CPM and PERT, Explain the similarities and differences.

A project scheduled has following characteristics: construct
PERT for the data

Activity	Name	Time	Activity	Name	Time (days)
1-2	A	4	5-6	G	4
1-3	B	1	5-7	H	8
2-4	C	1	6-8	I	1
3-4	D	1	7-8	J	2
3-5	E	6	8-10	K	5
4-9	F	5	9-10	L	7

TUTE SHEET NO. 3

Que 1 Consider the following game. Player 1 moves first and can take action A or B. Player 2 observes the action of Player 1 and independently of the action of Player 1 can take action A or B. Once the players have chosen their actions a die is thrown. If the result of the die roll is 4 or less the payoffs obtained by the players are given by

	A	B
A	(2,1)	(1,3)
B	(0,4)	(3,0)

If the result of the die roll is 5 or more the payoffs obtained by the players are given by

	A	B
A	(0,8)	(6,0)
B	(5,2)	(2,6)

i) Draw the tree depicting the extensive form of the game.
ii) Solve the game using recursion.
iii) Give the matrix form of the game

Que 2. i) By removing all strategies which are dominated by pure or mixed strategies, derive the reduced version of the following matrix game.

ii) Derive the minimax solution of this game.

	D	E	F	G
A	(3,5)	(4,1)	(2,5)	(1,3)
B	(4,2)	(6,3)	(3,5)	(2,4)
C	(5,4)	(3,6)	(4,3)	(5,4)

Que 3 a) Write down the steps of the graphical method to obtain an optimal solution to a linear programming problem.

b) Solve using Simplex method: Maximize $Z = 5x_1 + 3x_2 + 6x_3$; Subject to: $2x_1 + 4x_2 + 9x_3 < 10$ $x_1 + 3x_2 + x_3 \leq 23$; $x_1 + 4x_2 + x_3 = 10$; $x_1 , x_2 , x_3 > 0$

Que 4 Compare between Assignment problem and Transportation problem.

Que 5 a) What are the steps involved in the solution of (2 x n) and (m x 2) games.

b) Solve the following (4 x 2) game.

Que 6 a) Give essential characteristics of queuing procedure.

b) On an average 96 patients per 24 hours day require the service of an emergency clinic. Also on an average, a patient requires 10 minutes of active attention. Assume that the facility can handle only on emergency at a time, Suppose that it costs the clinic Rs. 100 per patient treated to obtain an average servicing time of 10 minutes and that each minute of decrease in this average time would cost Rs. 10 per patient treated. How much would have to be budgeted by the clinic to decrease the average six of the queue from 1 1/3 patients to ½ patient.

Que 7 a) Explain shortly the (M/M/I) : (∞ / FIFO): Mean and variance of the queue length. Average waiting length.

b) At a railway station, only one train is handled at a time. The railway yard is sufficient only for two trains to wait while other is given signal to leave the station. Trains arrive at the station at an average rate of 6 per hour and the railway station can handle them on an average of 12 per hour. Assuming Poisson arrivals and exponential service distribution, find the steady-state probabilities for the various number of trains in the system. Also find the average waiting time for a new train coming into the yard.

Que 9 a) What are the advantages and disadvantages of simulation?

b) Describe Monte Carlo method of stimulation.

TUTE SHEET NO. 4

1. Explain the terms a) Feasible solution b) Basis c) Alternative optima
2. Draw a flowchart for the computational procedure for a LPP using Simplex method.
3. Explain any three applications of LPP in management.
4. Compare simplex method and dual simplex method.
5. Briefly explain sensitivity analysis.
6. Write short note on traveling salesman problem.
7. Briefly describe the steps for solving a Transportation Problem.
8. Write short note on two Person zero sums game.
9. What do you mean by crashing? Write two advantages.
10. What are the basic characteristics of a queuing System.
11. What is the importance of Poisson and Exponential distribution in Queuing Theory.
12. Write short note on simulation.

BT—8 /M-17
OPERATION RESEARCH
Paper-ME-406E

Note : Attempt five questions in all, selecting at least one question from each unit. All questions carry equal marks. Assume the missing data, if any

Unit-I

L Write a detailed note on die use of models for decision making. The answer should specifically cover the following:

(a) Need for model building

(b) Type of model appropriate to the situation.

(c) Steps involved *in* the construction of the model 20

2 Reduce the following L.P. problem to the standard from: Determine $x \geq 0$, so as to minimize $G = 2x + y + z$; Subject to $-5x + 2y \leq 5$, $3x + 2y + 4z \geq 7$, $2x + 5z \leq 3$

Unit - II

3. Find the optimum solution to the following transportation problem in which the cells contain the transportation cost in rupees.

	W1	W_2	W_3	W_4	W_5	Available
	7	6	4	5	9	
	8	5	6	7	8	
	6	8	9	6	5	
	5	7	7	8	6	
Required	30	30	15	20	5	100 (Total)

4. A factory has four machines to do three jobs. Each job can be assigned to only one machine. The cost of each job on each machine is given in the following Table: Machines and jobs

	A	**B**	**C**	**D**
X	**18**	**24**	**28**	**32**
Y	**8**	**13**	**17**	**19**
Z	**10**	**15**	**19**	**22**

What are the job assignments which minimize the cost.

Unit- III

5. Two persons A & B work on the station assembly line. The distributions of activity times at their stations are:

Time in sec	Time frequency for A	Time Frequency for B
10	3	2
20	7	3
30	10	6
40	15	8
50	35	12
60	18	9
70	8	7

(a) Simulate operation of the line for eight items.

(b) Assuming B must wait until A completes the first item before starting work, will he have to wait to process any of the other eight items ? 20

6. Explain the various steps involved in the Decision Theory Approach. Which, are the decision criterions available for the condition of uncertainty ?

Unit-IV

7. Ships arrive at a port at the rate of 1 in every 4 hours with exponential distribution of inter arrival times. Hie time a ship occupies a berth for unloading has exponential distribution with an average of 10 hours. If the average delay of ships waiting for berths is to be kept below 14 hours, how many berths should be provided at the port ? 20

8. Explain Theory of Games and discuss in detail the importance of terminology used in game theory. 20

	B. Tech. VIth Semester Mechanical Engineering					
CSE-209N	**ESSENTIALS OF IT**					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3 hrs.**
Purpose	**To introduce the concepts of Object Oriented Programming using Java and RDBMS**					
COURSE OUTCOMES						
CO1	Solve Problems using various efficient and reliable Algorithms					
CO2	Design and Study the basic concepts in Java					
CO3	Document and implement Object oriented paradigms and design models in Java					
CO4	Design and study RDBMS Modeling and its program implementation					

UNIT I

Problem Solving Techniques: Introduction to Problem Solving, Introduction to Algorithms and Flowchart, Searching algorithms: Linear search, Binary search and Sorting algorithms: Insertion and Selection sort, Basic Data Structures: Stack, and Linear Queue.

UNIT II

Programming Basics: Identifiers, Variables, Data Types, Operators, Control Structures: Loop, If else, Nested If, Switch Statement, Arrays, Strings, Object Oriented Concepts: Class & Object, Operator, Instance Variables & Methods, Access Specifiers, Reference Variables: This, Super, Parameter Passing Techniques, Constructors, Static, and Command Line Arguments.

UNIT III

Relationships: Inheritance, Types of Inheritance, Static Polymorphism: Method Overloading, Constructor Overloading, Method Overriding, Abstract, Interface, Introduction to Packages.

UNIT IV

RDBMS: Data Processing, Database Technology, Data Models, Data Independence, ER Modeling Concept, ER-notations, Converting ER Diagram into Relational Schema, Definition of Keys: Primary key, Foreign key, Unique Key.

SQL: DDL Statements, DML Statements, DCL Statements, Joins, Sub queries, Views.

Books on Java

1. Java: The Complete Reference, Seventh Edition. Herbert Schildt, McGraw-Hill Education. Programming with Java 3e A Primer, E Balagurusamy, McGraw Hill Education.
2. Introduction to Java Programming, K. Somasundaram , Jaico Publishing House; 1st edition

Books on RDBMS, Oracle, MYSQL

1. Fundamentals of Database Systems, with E-book (3rd Edition) by Shamkant B. Navathe, Ramez Elmasri, Published by Addison Wesley Longman , January 15th , 2002
2. MySQL by Paul DuBois Published by New Riders.
3. Murach's MySQL Paperback, Joel Murach , Published by Shroff/Murach, 2012.
4. SQL: The Complete Reference , James R. Groff, Paul N. Weinberg, Published by McGraw-Hill Companies, March 1999.
5. Schaum's Outline of Fundamentals of Relational Databases, Ramon Mata-Toledo, Published by McGraw-Hill, 2000.

NOTE: In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.

Tutorial Sheet-1

1) Problem Solving Techniques: Introduction to Problem Solving
2) Searching algorithms: Linear search, Binary search
3) Sorting algorithms: Insertion and Selection sort,
4) Basic Data Structures: Stack, and Linear Queue.

Tutorial Sheet-2

1) Explain Control Structures: Loop, If else, Nested If, Switch Statement,
2) What do you mean by Arrays and Strings,
3) Object Oriented Concepts: Class & Object Parameter Passing Techniques?
4) What do you mean by Constructors? Explain?

Tutorial Sheet-3

1) Explain Inheritance, Types of Inheritance?
2) Explain Method Overloading, Constructor Overloading, Method Overriding?
3) Explain Polymorphism?
4) Introduction to Packages?

Tutorial Sheet-4

1) What is RDBMS- Data Processing, Database Technology?
2) Explain Data Models?
3) What do you by ER Modeling?
4) Definition of Keys: Primary key, foreign key, Unique Key?
5) What do you mean by DDL, DML, DCL Statements?

	B. Tech. VIth Semester Mechanical Engineering					
ME-308N	**COMPUTER AIDED DESIGN AND MANUFACTURING**					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time (Hrs.)**
4	**0**	**-**	**75**	**25**	**100**	**3**
Purpose	The subject empowers the students to know about the extreme function of computer in designing, manufacturing as well as in the business scenario.					
Course Outcomes						
CO1	Student gets aware about the introduction of CAD/CAM, and CIM. This unit explains the history and application CAD/CAM.					
CO 2	Student gets aware about the Modeling of different types of curves, surface and solid. The modeling is used for further analysis.					
CO 3	To know about the transformation of points and lines in computer aided software. Group technology is used for utilization machines.					
CO 4	Student knows the usages of the numerical control machines and its code. How computer is useful in making the process planning.					

Unit-I

Introduction to CAD/CAM, Historical Development, Industrial look at CAD/CAM Application of CA/CAM, Display devices, Input/ Output Devices, CPU.

Introduction to CIM, Definition, Nature of Elements of CIM, CIM Wheel,

Introduction to computer aided quality control, Contact and Non Conduct Inspection Method.

Unit-II

Wireframe modeling, Representation of curves, Parametric and non parametric curves, straight lines, Hermite cubic splines, B splines curves.

Plane surface, ruled surface, surface of revolution, bi-cubic surface, Bezier surface, B spline surface, Solid modeling, boundary representation, sweeping, parametric solid modeling.

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Unit-III

Introduction, Transformation of points & line, 2-D translation, rotation, Reflection, Scaling, shearing and combined transformation, Homogeneous coordinates, Orthographic and perspective Projections.

Group technology, Part families, Part classification and coding, Optiz method, product flow analysis, Machine cell Design, Advantages of GT

Unit-IV

Numerical control, Types of NC systems, MCU & other components, Co-ordinate system, NC manual part programming, G & M codes, part program for simple parts, Computer assisted part programming.

Introduction, FMS component, Types of FMS, FMS layout, planning for FMS, advantage and applications

Introduction, conventional process planning, Steps in variant process planning, types of CAPP, planning for CAPP

Text books:

1. **Chris McMahon and Jimmie Browne**, CAD/CAM – Principle Practice and Manufacturing Management, Addison Wesley England, Second Edition, 2000.

2. **Rogers, D.F. and Adams, A**., Mathematical Elements for Computer Graphics, McGraw Hill Inc, NY, 1989

3. **Ibrahim Zeid**, CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1992.

4. **M.P. Groover**, Automation, Productions systems and Computer-Integrated Manufacturing by Prentice – Hall

Reference Books:

1. **Ibrahim Zeid**, Mastering CAD/CAM, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

2. **P. Radhakrishnan, S. Subramanayan and V.Raju**, CAD/CAM/CIM, New Age International (P) Ltd., New Delhi.

3. **Groover M.P. and Zimmers E. W.**, CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall International, New Delhi, 1992.

4. **Dr. Sadhu Singh**, Computer Aided Design and Manufacturing, Khanna Publishers, New Delhi, Second Edition, 2000.

5. **Chang, Wang &Wysk** Computer Aided Manufacturing. Prentice Hall

6. **Kundra** & **Rao**, Numerical Control and Computer Aided Manufacturing by, Rao and Tiwari, Tata Mc-Graw Hill.
7. **Mattson**, CNC programming Principles and applications, Cengage Learning India Pvt.
   Ltd. Delhi

NOTE: In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.

Lecture Plan
Computer Aided Design and Manufacturing
ME-308N

Month	Class	Topic/Chapter Covered	Academic Activity	Test/Assignment
Jan.	6th Semester	Introduction to CAD/CAM, Historical Development	Teaching	
Jan.	6th Semester	Industrial look at CAD/CAM Application of CA/CAM, Display devices, Input/ Output Devices, CPU	Teaching	
Jan.	6th Semester	Introduction to CIM, Definition, Nature of Elements of CIM	Teaching	
Jan.	6th Semester	CIM Wheel, Introduction to computer aided quality control	Teaching	
Jan.	6th Semester	Contact and Non Conduct Inspection Method	Teaching	
Jan.	6th Semester	Wireframe modeling	Teaching	
Jan.	6th Semester	Representation of curves, Parametric and non-parametric curves	Teaching	
Jan.	6th Semester	Straight lines, Hermite cubic splines	Teaching	
Jan.	6th Semester	B splines curves	Teaching	
Jan.	6th Semester	Plane surface, ruled surface	Teaching	
Jan.	6th Semester	Surface of revolution, bi-cubic surface	Teaching	Assignment
Feb.	6th Semester	Bezier surface, B spline surface	Teaching	
Feb.	6th Semester	Solid modeling, boundary representation	Teaching	
Feb.	6th Semester	Sweeping, parametric solid modeling	Teaching	
Feb.	6th Semester	Introduction, Transformation of points & line	Teaching	
Feb.	6th Semester	2-D translation, rotation	Teaching	

Feb.	6th Semester	Reflection, Scaling	Teaching	
Feb.	6th Semester	Shearing and combined transformation	Teaching	
Feb.	6th Semester	Homogeneous coordinates, Orthographic Projections	Teaching	Assignment
March	6th Semester	Perspective Projections	Teaching	
March	6th Semester	Group technology	Teaching	
March	6th Semester	Part families	Teaching	
March	6th Semester	Part classification and coding, optiz method	Teaching	
March	6th Semester	Product flow analysis,	Teaching	
March	6th Semester	Machine cell Design, Advantages of GT	Teaching	
March	6th Semester	Numerical control, Types of NC systems	Teaching	
March	6th Semester	MCU & other components	Teaching	
March	6th Semester	Co-ordinate system	Teaching	
March	6th Semester	NC manual part programming	Teaching	
March	6th Semester	G & M codes	Teaching	Assignment
April	6th Semester	Part program for simple parts,	Teaching	
April	6th Semester	Computer assisted part programming	Teaching	
April	6th Semester	Introduction, FMS component	Teaching	
April	6th Semester	Types of FMS, FMS layout	Teaching	

April	6th Semester	planning for FMS, advantage and applications	Teaching	
April	6th Semester	Introduction, conventional process planning, Steps in variant process planning	Teaching	
April	6th Semester	Types of CAPP, planning for CAPP	Teaching	Assignment

TUTORIAL SHEET -1

1. Define CAD Explain fundamental reasons for implementing a computer aided design system.
2. Explain historical perspective of CAD.
3. Write short note on CIM.
4. Explain design process in details.
5. Explain the application of computers for design.
6. Explain the benefits of computer aided design.
7. Explain the following :

   a. Geometric modeling.

   b. Solid modeling.

   c. Explicit, Implicit, intrinsic and parametric equations.

TUTORIAL SHEET -2

1. Explain Transformation of points and line.
2. Explain 2 D rotation, reflection, scaling and combined transformation.
3. Explain 3 D scaling, rotation, reflection & translation.
4. Explain combined transformation.
5. Write short notes on the following:

   a. Orthographic projections.

   b. Perspective projections.

6. Explain tangents and normal concept used for curves.

7. Which are the various blending functions used for curves.

8. Explain Bezier curves and b-spline curves.

TUTORIAL SHEET -3

1. Explain algebraic and geometric forms of surfaces.

2. Which are the various blending functions used for surfaces.

3. Explain reparametrization, sixteen point form and four curve form of surfaces

4. Explain plane surfaces, ruled surface and surface of revolution

5. Explain bi-cubic surface, Bezier surface and B-spline surfaces.

6. Explain boundary representation for solids.

7. Explain sweep representation.

8. Write short notes on the following:

   a. Cell decomposition

   b. Spatial occupancy enumeration

TUTORIAL SHEET – 4

1. Define group Technology. Explain part families concepts

2. Explain parts classification and coding.

3. Explain group Technology and machine cells.

4. Explain the benefits of group Technology

TUTORIAL SHEET -5

1. Explain the types of manufacturing systems

2. Explain the various FMS components.

3. Explain types of FMS & various types of layouts in FMS.

4. Discuss advantages and applications of FMS.

5. Compare Transfer tines, CIM & NC in terms of part variety and production volume.

6. Compare special systems, FMS and manufacturing cell in terms of part variety and production volume.

TUTORIAL SHEET -6

1. Explain Traditional process planning and automated process.
2. Explain Retrieval type process planning by example.
3. Explain generative process planning system by example.
4. Which are the various steps used in variant process planning?
5. Explain the benefits of CAPP

TUTORIAL SHEET -7

1. Explain Fixed, programmable and flexible automation.
2. Explain the types of NC systems.
3. Explain the basic components of an NC system.
4. Explain NC procedure.
5. Explain NC co-ordinate system.
6. Explain NC motion control system.
7. Explain advantages, disadvantages and application of NC system.
8. Explain punched tape in NC, Tape coding and format.
9. What is computer job in computer assisted part programming?
10. Write short notes on the various NC part programming languages.
11. Explain various G & M codes. Prepare one programme for CNC lathe and one
    12. programme for CNC milling job.
12. Explain advantages of CAD I CAM in NC programming.

BT-6/M-15

COMPUTER AIDED DESIGN AND MANUFACJ"URING

Paper: ME-308-E

Time: 3 Hr M.M.:100

Note: Attempt any five questions, selecting at least one form each unit.

Unit-I

1. (a) Define CAD CAM & CIM. Give a brief description of their application in Industries. 12

   (b) What is Solid Modelling? Give its application. 8

2. Describe the various part classification and coding techniques used in Group technology in industries. Explain various structures with suitable examples. 20

Unit-II

3. A rectangular with coordinate A(2, 3), B (2, 5), C (6, 5) and (6,3) is reflected along line whose equation is y = 2x +4 and by 2 units in x direction and 2 units in y direction. Find coordinates of the object. 20

4. Find the equation of a Bezier curve points as P_0 (2,2,0), P_1 (2,3,0), P_2 (3,3,0),P_3 (3,2,0) and also find the points on the curve

   u=O, 1/4, 1/2, 3/4,1 20

Unit-Ill

5. Compare the following analytical surfaces: Ruled Surface and Tabulated cylinders. 20

6. Write short notes on following:

   CSG technique.

   B-rep technique

Unit-IV

7. Describe how following tasks are performed on machine through MDI:

   a. Copying a part of an existing program into program. 5

   b. Inserting an existing program (say program an arbitrary position in the currently running p. program no. 432).
   5

   c. Editing a program (say program no, 2345) in background, while executing another program (say program no. 1234). 5

   d. Tool offset setting. 5

8. (a) Define the flexibility in FMS. What are the various layouts used in FMS design? Explain them with their application.
   12

   (b) Explain the steps in manufacturing on a CNC system. 8

BT-6/M-17

COMPUTER AIDED DESIGN AND MANUFACTURING

Paper: ME-308-E

Time: 3 Hr M.M.:100

Note: Attempt any five questions, selecting at least one form each unit. All question carry equal marks

Unit-I

1. Compare traditional and CAD/CAM based product cycle.
2. Discuss with example the following: classification and coding system, monocode, polycode, and mixed code.

Unit-II

3. A triangle is defined by its vertices A (0, 2), (1, 3), (0,4), and rotated by 30^{o} clockwise about point (0,4). Find the new coordinates.
4. Find the radius and center of a circle passing through three points.

Unit-Ill

5. Define Bezier surface. Explain various characteristics of this surface.

6. Explain constructive solid geometry modeling technique in details with example.

Unit-IV

7. Write a note on:

   a. Explain 3 axis and 5 axis control.

   b. Explain the factor responsible for the development of numerical control.

8. Write a note on:

   a. What are the function of post processor?

   b. Describe the physical subsystem of an FMS

	B. Tech. VIth Semester Mechanical Engineering					
ME-310N	**MACHINE DESIGN-II**					
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Total**	**Time (Hrs.)**
2	**0**	**4**	**75**	**25**	**100**	**3**
Purpose	To deal effectively with engineering problems associated with an individual machine component.					
Course Outcomes						
CO 1	To analyze the force components acting on the gears and solve design problems of different types of gears.					
CO 2	To solve design problems of belts, chains, pulleys and friction clutches and brakes.					
CO 3	To make selection of bearings from manufacturer's catalogue and solve spring design problems.					
CO 4	To design and solve the problems of IC engine components and flywheels.					

UNIT-I

Gear Drives: Classification of gears, selection of type of gears, law of gearing, standard systems of gear tooth, interference and undercutting, backlash, **Spur Gears:** geometry and nomenclature, force analysis, material selection, beam strength of gear tooth, effective load on gear tooth, module estimation based on beam strength, wear strength of gear tooth, module estimation based on wear strength, spur gear design procedure. **Helical Gears:** geometry and nomenclature, force analysis, beam strength of helical gears, effective load on gear tooth, wear strength of helical gears, design procedure. **Bevel Gears:** geometry and nomenclature, force analysis, beam strength of bevel gears, effective load on gear tooth, wear strength of bevel gears, design procedure. **Worm Gears:** terminology, force analysis, friction in worm gears, material selection, strength rating and wear rating, thermal considerations and design procedure.

UNIT-II

Flat Belt Drives and Pulleys: Introduction, Selection of flat belts from manufacturer's catalogue, Pulleys for flat belts. **V-Belts and Pulley:** selection of V-Belts and V-grooved pulley. **Chain Drives:** roller chains, geometric relationships, polygonal effect, power rating, sprocket wheels, design of chain drives, chain lubrication.

Clutches: Various types of clutches in use, design of friction clutches-single disc, multidisc, cone & centrifugal, torque transmitting capacity, friction materials, thermal considerations. **Brakes:** Various types of brakes, self-energizing condition of brakes, design of shoe brakes – internal & external expanding, band brakes, thermal considerations in brake designing.

UNIT-III

Springs: Types of springs, design for helical springs against tension and their uses, compression and fluctuating loads, design of leaf springs, surging in springs.

Bearings: Classification, selection of bearing type, static and dynamic load carrying capacity, equivalent bearing load, load-life relationship, selection of bearings from manufacturer's catalogue, selection of taper roller bearing, design for cyclic loads and speeds, bearing failure-causes and analysis. **Sliding Contact Bearings:** design of journal bearings using Raimondi and Boyd's Charts.

UNIT IV

I.C. Engine Components: Design of cylinder, design of studs for cylinder head, design of piston, design of crank shaft, design of connecting rod.

Flywheel: Flywheel materials, torque analysis, coefficient of fluctuation of energy, design of solid disc and rimmed flywheel.

Text books:

1. Mechanical Engineering Design, Joseph E. Shigley and Charles R. Mischke, Tata McGraw Hill Book Co.
2. Design of Machine Element,V. B. Bhandari, Mc Graw Hill Edu. Pvt. Ltd.
3. Machine Component Design, Robert C. Juvinall and Kurt M. Marshek, Wiley India Pvt. Ltd.
4. Mechanical Design of Machine Elements and Machines, Collins and Busby, Wiley India Pvt. Ltd.

References books:

1. Machine Design by Sharma and Aggarwal
2. Machine Design-an integrated Approach, Robert L. Norton, Addison Wisley Longman
3. PSG Design Data Book by PSG college of Engineering, PSG Publication.
4. Design Data Handbook for Mechanical Engineers by K. Mahadevan and K. Balaveera Reddy.

NOTE: In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.

Lecture Plan
Machine Design-II
ME-310N

Month	Class	Topic/Chapter Covered	Academic Activity	Test/Assignment
Jan.	6th Semester	Gears-types and application and gear terminology	Teaching	
Jan.	6th Semester	Law of gearing-conjugate action and interference in gears	Teaching	
Jan.	6th Semester	Gear tooth profiles, involute profile - basics, Influence of number of teeth and pressure angle	Teaching	
Jan.	6th Semester	Analysis of forces on spur, and helical gears and Lewis equation for design	Teaching	
Jan.	6th Semester	Dynamic loading and wear-Buckingham equations for design	Teaching	
Jan.	6th Semester	Force analysis on bevel and worm gears	Teaching	
Jan.	6th Semester	Design approach for bevel gears-equivalent tooth	Teaching	
Jan.	6th Semester	Design of fixed ratio gear box- general design procedure	Teaching	
Jan.	6th Semester	Design of Flat Belt Drive and type of Flat belt drive	Teaching	
Jan.	6th Semester	Design of Cast iron flat belt pulley	Teaching	
Jan.	6th Semester	Design of V-Belt Drive and Types of V-belts and pulleys	Teaching	Assignment
Feb.	6th Semester	Design of Rope Drive and selection of wire rope.	Teaching	
Feb.	6th Semester	Design of chain drive and selection of chains.	Teaching	
Feb.	6th Semester	Type of clutches and design of single plate clutch.	Teaching	
Feb.	6th Semester	Design of multiple disc clutch.	Teaching	
Feb.	6th Semester	Type of brakes and Design of single shoe brake	Teaching	
Feb.	6th Semester	Design of Double Shoe Brake	Teaching	
Feb.	6th Semester	Helical Springs, Stresses and Deflections	Teaching	
Feb.	6th Semester	Design Principles of Helical Springs	Teaching	Assignment
March	6th Semester	Stresses and Deflections, Design principles of leaf Springs	Teaching	
March	6th Semester	Types of Sliding contact Bearings and introduction to Hydrodynamic Lubricated Bearings	Teaching	
March	6th Semester	Design of Journal Bearing	Teaching	

March	6th Semester	Types of Rolling contact bearings and introduction to ball Bearings & Roller bearings	Teaching	
March	6th Semester	Design & Selection of Rolling contact bearings.	Teaching	
March	6th Semester	Design of cam & Follower	Teaching	
March	6th Semester	Design of Cylinder	Teaching	
March	6th Semester	Design of Piston	Teaching	
March	6th Semester	Design of Piston	Teaching	
March	6th Semester	Design of Crank Shaft (Case-I)	Teaching	
March	6th Semester	Design of Crank Shaft (Case-II)	Teaching	Assignment
April	6th Semester	Design of Connecting rod	Teaching	
April	6th Semester	Design of Connecting rod	Teaching	
April	6th Semester	Design of Crane Hook	Teaching	
April	6th Semester	Fly wheel basic concepts -design requirements	Teaching	
April	6th Semester	Fly wheel basic concepts -design requirements	Teaching	
April	6th Semester	Moment diagram and energy estimations	Teaching	
April	6th Semester	Moment diagram and energy estimations	Teaching	Assignment

Tutorial Sheet-I

1. Two spur gears have a diametral pitch of 6. Gear 2 has 24 teeth, and gear 3 has 48. The working pressure angle is 20°, and both gears are standard involutes. Determine the length of the contact line and the contact ratio.
2. A bronze spur pinion rotating at 600 r.p.m. drives a cast iron spur gear at a transmission ratio of 4:1. The allowable static stresses for the bronze pinion and cast iron gear are 84 MPa and 105 MPa respectively. The pinion has 16 standard 20° full depth involute teeth of module 8 mm. The face width of both the gears is 90 mm. Find the power that can be transmitted from the standpoint of strength.
3. A 21 teeth gear has 20^o full depth involute teeth with a module of 12mm. (a) Calculate the radii of pitch circle, base circle and addendum circle (b) Determine the tooth thickness at base circle, pitch circle and addendum circle. Comment on the top land thickness.
4. A pair of helical gears is to transmit 15 kW. The teeth are 20° stub in diametral plane and have a helix angle of 45°. The pinion runs at 10000 r.p.m. and has 80 mm pitch diameter. The gear has 320 mm pitch diameter. If the gears are made of cast steel having allowable static strength of 100 MPa; determine a suitable module and face width from static strength considerations and check the gears for wear, given σ_C = 618 MPa
5. Design the teeth for a pair of cast iron spur gears with cast teeth to transmit 26 kW. The pinion runs at 50 rev/min and the velocity ratio is to be 2.5. Decide upon a suitable grade of cast iron and find the module face and diameters, centre distance for the gears.
6. In a drive, a velocity ratio of 2.5 with a centre distance of 70 mm is desired. (a) Determine the pitch diameter of the gears with 20o full depth involute teeth; (b) Is there any interference in the system? If so, how will you avoid it? (c) Determine the contact ratio, (d) Find the dedendum, addendum, root diameters and the tip clearance, (e) If the centre distance is increased by 1.5%, what will be the new pressure angle?
7. A helical pinion having 20 teeth transmit 30 kW power at 30 rev/sec. The normal module is 4 mm, while face width is 36 mm. The normal pressure angle is 200 and helix angle is 300. If the gear pair is made of steel, calculate the maximum contact stress in the tooth.
8. A pair of straight bevel gears must transmit 15 kW at 1250 rev/min of the 18 tooth pinion. Speed reduction ratio is 3.5 : 1. Use 14.5 full depth teeth. Select the materials to obtain a compact design. Determine the module, the gear face, pitch diameter and pitch cone angle for both gears.

9. Design a high efficiency worm gear speed reducer to transmit continuously the rated power output of 15 kW motor running at 1750 r.p.m. The steel worm having hardness 250BHN is integral with a motor shaft. The speed ratio is 10, while the phosphor bronze gear should not have less than 40 teeth.
10. Design a worm gear reducer to transmit 11 kW power from an electric motor running at 1500 r.p.m to a machine running at 75 r.p.m. The loading is intermittent (less than 3 hours per day) and steady.
11. Design a worm gear set to transmit 12 kW power from a motor shaft rotating at 1400 r.p.m to a machine rotating at 75 r.p.m. The center distance between the shafts is 250 mm, while the normal pressure angle is 20^0.

Tutorial Sheet-II

1. Two parallel shafts, whose centre lines are 4.8 m apart, are connected by an open belt drive. The dia. of the larger pulley is 1.5 m and smaller pulley is 1 m. the initial tension in the belt when stationary is 3 KN. The mass of the belt is 1.5 Kg/m length. The coefficient of friction between belt and pulley is 0.3. Taking centrifugal tension in to account, calculate the power transmitted, when the smaller pulley rotates at 400 r.p.m.
2. A V-belt is driven on a flat pulley and a V-Pulley. The driver transmits 20 KW from a 250 diameter V-pulley operation at 1800 r.p.m. to a 900 mm diameter flat pulley. The centre distance is 1 m, the angle of groove 40^0 and coefficient of friction = 0.2. If density of belting is 1110 Kg/m^3 and allowable stress is 2.1 Mpa for belt material what will be the number of belts required if C-size V-belt having 230 mm^2 cross-sectional areas is used.
3. A V-belt is driven on a flat pulley and V-pulley. The drive transmits 20 kW from a 250 mm dia. V-pulley operating at 1800 rpm to a 900 mm dia flat pulley. The centre distance is /m, the angle of groove 40^o and μ= 0.2, If density of belting is 1110 kg/m^3 and allowable stress is 2.1 MPa for belt material, what will be the number of belts required. If (size V-belts having 230 mm^2 cross sectional area are used.)
4. Select a roller chain for a bucket elevator to be driven by a gear motor. The gear motor has 5 kW power and runs at 100 rpm. The speed of the bucket elevator sprocket is 50 rpm. The centre distance is 1250 mm. The elevator is to operate 16 hrs per day. Assume variable load with minor shocks.
5. Discuss different types of clutches. How does the function of a brake differ from that of clutch?

6. Give a complete design analysis of a single plate clutch, with both sides effective, of a vehicle to transmit 22 kW at a speed of 2800 rpm allowing for 25% overload. The pressure intensity is not to exceed 0.08 N/mm2 and the surfae speed at the mean radius is not to exceed 2000 m/min. Take μ as 0.35 for surfaces and outside dia. of the surface is to be 1.5 times the inner dia. The axial thrust is to be provided by 6 springs of about 24 mm coil dia. For springs the safe shear stress is to be limited to 420 MPa & G=80 kN/mm^2.
7. A cone clutch is used to connect an electric motor running at 1440 rpm with a machine that is stationary. The machine is equivalent to a rotor of mass 150 kg and radius of gyration as 250 mm. The machine has to be brought to full speed of 1440 rpm from a stationary condition in 40 sec. The semi cone angle is 12.5 degree. The mean radius of the clutch is twice the face width. The co-efficient of friction is 0.2 and the normal intensity of pressure between contacting surfaces should not exceed 0.1 N/mm^2. Assuming uniform wear condition, calculate.
    i. The inner and outer diameter.
    ii. The face width of friction lining.
    iii. The force required to engage the clutch.
    iv. The amount of heat generated during each engagement of clutch.
8. A multiple disc clutch, steel on bronze, is to transmit 4.5 kW at 750 r.p.m. the inner radius of the contact is 40 mm and the outer radius of the contact is 70 mm. The clutch operates in oil with an expected coefficient of 0.1. The average allowable pressure is 0.35 N/mm^2. Find
    i. The total number of steel and bronze disc
    ii. The actual axial force required.
    iii. The actual average pressure.
    iv. The actual max. Pressure.
9. In a band and block brake, the band is lined with 14 blocks, each of which subtends an angle of 20o at the drum centre. One end of band is attached to the fulcrum of the brake lever and the other to a pin 150 mm from the fulcrum. Find the force required at the end of the lever 1 m long from the fulcrum to give a torque of 4 kN-m. The dia of brake drum = 1 m μ= 0.25 between the blocks and the drum.
10. A simple band brake operates on a drum of 600 mm in diameter that is running at 200 r.p.m. the coefficient of friction is 0.25. The brake band has a connect of 270^0,one end is fastened to a fixed pin and the other end to the brake arm 125 mm from the fixed beam.

The straight brake arm is 750 mm long and placed perpendicular to the diameter that bisects the angle of contact.

a) What is the pull necessary on the end of the brake arm to stop the wheel if 35 kW is being absorbed? What is the direction for this minimum pull?
b) What width of steel band of 2.5 mm thick is required for this brake if the maximum tensile stress is not to exceed 50 Mpa?

Tutorial Sheet-III

1. A full journal bearing of 50 mm diameter and 100 mm long has a bearing pressure of 1.4 N/mm^2. The speed of the journal is 900 r.p.m. and the ratio of journal diameter to the diametral clearance is 1000. The bearing is lubricated with oil whose absolute viscosity at the operating temperature of 75°C may be taken as 0.011 kg/m-s. The room temperature is 35°C. Find: (a) The amount of artificial cooling required (b) The mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10°C. Take specific heat of the oil as 1850 J / kg / °C.
2. Design a journal bearing for a centrifugal pump from the following data: Load on the journal = 20 000 N; Speed of the journal = 900 r.p.m.; Type of oil is SAE 10, for which the absolute viscosity at 55°C = 0.017 kg / m-s; Ambient temperature of oil = 15.5°C; Maximum bearing pressure for the pump = 1.5 N / mm2 Calculate also mass of the lubricating oil required for artificial cooling, if rise of temperature of oil be limited to 10°C. Heat dissipation coefficient = 1232 W/m/°C.
3. A Semi elliptical laminated vehicle spring to carry a load of 6000 N is to consist of seven leaves 65 mm wide two of the leaves extending the full length of the spring. The spring is to be 1.1 m in length and attached to the axle by two U bolts 80 mm apart. The bolt held the central portion of the spring so rigidly that they may be considered equivalent to a find having a width equal to the distance between the bolts. Assume a design a stress for spring material as 350 MPa. Determine: - Thickness of leaves, Deflection of spring, Diameter of eye, Length of leaves, Radius to which leaves are initially bent.
4. Give a complete design a helical compression spring to support the load of 3 KN. The natural frequency of the system is not to exceed 1.5 Hz.
5. Design a helical spring for a spring balance to weight 50 N, scale length is 50mm and the spring index is to be 5, choose your own material and safe working stress for the same.
6. Design a journal bearing for a centrifugal pump from the following data:

Load on the journal = 20000N; speed of the journal = 900 r.p.m.; type of oil is SAE 10, for which the absolute viscosity at 55^oC = 0.017 kg/m-s; ambient temperature of oil = 15.5 ^oC; maximum bearing pressure for the pump = 1.5 N/mm^2. Calculate the mass of the lubricating oil req. for artificial cooling, if rise of temp. of oil be 10 ^oC.

Tutorial Sheet-IV

1. Design a cylinder and cylinder head for 4 stroke engine with the following data. Cylinder bore= 150 mm, Max gas pressure = 3.2 N/mm^2 Assume suitable additional data.
2. Design a cylinder and cylinder head for a 4 stroke C.I engine with the following data. Brake power = 5 KW, Engine Speed = 1200 rpm Indicated mean effective pressure = 0.35 N/mm^2. Mechanical efficiency = 80% Assume additional suitable data.
3. A C.I piston to be used for a single acting four stroke engine with the following data. Cylinder bore = 100 mm, Stroke = 120 mm Max gas pressure 5 N/mm^2, Break mean effective pressure = 0.65 N/mm^2, Speed = 2200 rpm, Fuel consumption = 0.227 Kg/kW-h Find the suitable thickness of the piston head. Thermal conductivity for the cast iron is 46 J/s m ^0C and allowable temperature difference is 222^0C
4. Design the piston for a single acting four stroke engine with the following specification: Cylinder bore = 0.30 m, Stroke length = 0.375 m, maximum gas pressure = 8 MPa, break mean effective pressure = 1.15 MPa, fuel consumption = 0.22 Kg/kW/hr, Speed = 500 r.p.m.
5. Design a connected rod for 4 stroke petrol engine with the following data. Piston diameter = 100 mm , Stroke 140 mm Length of connecting rod (center to center) = 315 mm, Weight of reciprocating part = 18.2 N Speed = 1500 rpm with possible speed of 2500 rpm, Max explosive pressure = 2.45 N/mm^2.
6. A connecting rod is required to be designed for a high speed, four stroke I.C engine. The following data may be assumed. Diameter of piston = 88 mm, stroke = 125 mm, length of connecting rod (centre to centre) = 300 mm, engine speed = 2200 r.p.m (when developing 50 kW), compression ratio = 6.8:1, maximum explosion pressure = 3.5 N/mm^2.
7. The following particulars refer to a four stroke cycle diesel engine: cylinder bore = 150 mm; stroke = 188 mm; RPM = 1200; Max. gas pressure = 5.6 N/mm^2; mass of reciprocating parts = 1.75 kg; elastic limit compressive stress of connecting rod = 350 MPa; the ratio of length of connecting rod to crank is 4 and FOS = 5; bearing pressure of

wrist pin and crank pin is 10 N/mm^2 and 7 N/mm^2 ; allowable stress in bolts = 35 N/mm^2. Draw dimensioned sketch of the connecting rod showing the provision of lubrication.

8. Design a cast iron piston for a single acting four stroke engine for following data: Cylinder bore = 100 mm; stroke = 125 mm; maximum gas pressure = 5 N/mm^2; Indicated mean effective pressure = 0.75 N/mm^2; fuel consumption = 0.15 kg/BP/hr; HCV = 42 MJ/Kg; speed = 2000 rpm. Any other data required may be assumed.
9. Design a crank shaft for a single acting four stroke single cylinder engine for the following data: Bore = 400mm; Stroke = 600mm; Engine Speed = 200 rpm; Mean effective pressure = 0.5 n/mm^2; Maximum combustion pressure = 2.5 n/mm^2; weight of the flywheel = 50 kN; Total belt pull = 6.5 kN. The ratio of the connecting rod length to the crank radius is 5. Design the following parts of the crank shaft when the crank is at an angle of 35 ^{0}C from TDC.
    (i) Design of shaft under the flywheel.
    (ii) Design of right and left hand crank web.

MACHINE DESIGN-II

Paper-ME-310-E Opt. II

Time allowed: 4 Hours] *[Maximum marks: 100*

Note: *Attempt five questions in all, selecting at least one question from each unit. All questions carry equal marks. Use of machine design data book is allowed.*

Unit – I

1. (a) Why the tangential component of gear tooth force is called useful component? 5

(b) A pair of spur gears consists of a 24 teeth pinion, rotating at 1000 rpm and transmitting power to a 48 teeth gear. The module is 6 mm, while the face width is 60 mm. Both gears are made of steel with an ultimate tensile strength of 450 MPa. They are heat treated to a surface hardness of 250 BHN. Assume that velocity factor accounts for the dynamic load. Calculate

(i) Beam strength

(ii) Wear strength

(iii) The rated power that the gears can transmit, if service factor and the factor of safety are 1.5 and 2 respectively. 15

2. A pair of helical gears consists of 24 teeth pinion meshing with 72 teeth gear. Normal pressure angle is 20 deg. And the helix angle is 24 deg. The pinion rotates at 720 rpm. Normal module of gear is 5 mm and face width is 50 mm. Both pinion and gear are made of steel with S_{ut} = 600MPa. Gears are heat treated to a surface hardness of 360 BHN.

What power can be transmitted by the gear if the service factor is 1.4 and factor of safety is 2? Assume that velocity factor accounts for the dynamic load. 20

Unit-II

3. It is required to drive a V-belt drive to connect a 20 kW, 1440 rpm motor to a compressor running at 480 rpm for 15 hours per day. Space is available for a distance of approximately 1.2 m.

Determine:

(i) The specifications of the belt

(ii) Diameters of the motor and compressor pulley

(iii) The correct centre distance

(iv) The no. of belt 20

4. An automotive single plate clutch consists of two pairs of contacting surfaces. The outer diameter of the friction disc is 270 mm. The coefficient of friction is 0.3 and the maximum intensity of

pressure is 0.3 MPa. The clutch is transmitting a torque of 531 N-m. Assuming uniform wear theory, calculate:

(i) The inner diameter of the friction disc

(ii) Spring force required to keep the clutch engaged. 20

Unit-III

5. (a) The following data is given for a full hydrodynamic bearing :

Journal speed = 1260 rpm; journal diameter = 60mm; Bearing length = 60mm;

Radial clearance =0.04mm; Radial load =6 kN; minimum oil thickness = 0.008mm.

Specify the viscosity of the lubricating oil you will recommend for bearing. 15

(b) If the designation of a bearing is 6308, give its complete specifications from the SKFcatalogue and determine its life at 20000 N dynamic load. If the bearing rotates at 720 rpm, what was its life in hours ? 5

6. It is required to design helical compression spring subjected to a maximum force of 7.5 kN. The mean coil diameter should be 150 mm from space consideration. The spring rate is 75 N/mm. The spring is made of oil hardened and tempered steel wire with ultimate tensile strength of 1250MPa. The permissible shear for the spring wire is 30% of the ultimate tensile strength (G=81370 MPa).Calculate:

i. Wire diameter and

ii. no. of active coils. 20

Unit-IV

7. Design a piston for a four-stroke diesel engine developing 15kW power at 700 rpm. Other data is as follows

Crank radius = 110 mm; indicated mean effective pressure = 0.7 MPa; Maximum gas pressure = 5.1 MPa; mechanical efficiency =75%; heat dispersion through top = *5%* of heat produced; fuel consumption =0.16 kg per BP per hr; higher calorific value of fuel = 44000 kJ/kg; difference of temperature at the centre and the edge of piston head = 205 deg.; allowable stress for piston material = 35MPa; allowable stress for piston ring material = 80MPa; allowable pressure on piston barrel = 0.42 MPa; Allowable bearing pressure for gudgeon pin = 20MPa; Allowable pressure between piston and ring = 0.045 MPa; Allowable tension in piston pin = 90MPa. 20

8. A rimed fly wheel made of grey cast iron (mass density = 7100 kg/m^3) is used on a punching press running at mean speed of 200 rpm. The punching operation consists of one-

quarter revolution during which the flywheel is required to supply 3000 N –m of energy. The coefficient of speed fluctuations is limited to 0.2. The rim which contributes 90% of the required moment of inertia has a mean radius of 0.5 m due to space limitations. The cross-section of the rim is square. Determine its dimension. 20

BT-6 / M-18
MACHINE DESIGN-II
Paper-ME-310N Opt.-Il

Time allowed: 3 hours] [Maximum marks: 75

Note Attempt five questions in all, selecting at least one question from each unit. Use of machine design data book is allowed

Unit-I

1. (a) Give an expression for module estimation based on beam strength for spur gears. 07

(b) Design a compact pair of helical gear on strength basis to transmit 150 kW at 1400 rep-m of pinion. The teeth are 20 deg. involute full depths in diametral plane. The helix angle is 23 deg. and the speed ratio is 3:1 The Gears are made of alloy steel. The ultimate strength of the alloy steel is 1040 MPa 08

2, A pair of cast iron bevel gears connect two shafts at right angles. The pitch diameters of the pinion and gear are 80 mm and 100 mm respectively. The tooth profiles of the gears are of 14.5^0. composite forma The allowable static stress for both the gears is 55 MPa. If the pinion transmits 2.75 kW at 1100 rpm, find the module and number ofteeth on each gear from the standpoint of strength and check the design from the standpoint ofwear. Take surface endurance limit as 630 MPa and modulus of elasticity for cast iron as 84 kN/ mm^2 15

Unit-Il

It is required to design a chain drive to connect a 12 kW, 1400 rpm electric motor to a centrifugal pump running at 700 r.p.m. The service conditions involve moderate shocks.

(a) Select a properroller chain and give a list of its dimensions.

(b) Determine the pitch circle diameters of the driving and driven sprockets.

(c) Determine the no. of chain links

(d) Specify the correct centre distance between the axis of the sprockets. 15

4. Design a cone clutch to transmit 15 kW at 960 r.p.m. The outer cone is of cast iron and forms the part of I.C. engine flywheel. The overall dimensions restrict the mean diameter of the cone to 275 mm. The semi- cone angle is 15 deg. The inner cone is positioned by means of a centrally placed helical spring. 15

Unit-Ill

5. (a) A rolling contact bearing is subjected to the following work cycle: (a) Radial load of6000N at 150 r.p.m. for 25% of the time; (b) Radial load of 7500 N at 600 r.p.m. for 20% of the time; and (c) Radial load of 2000 N at 300 r.p.m. for 55% of the time. The inner ring rotates and loads are steady. Select a bearing for an expected average life of2500 hours. 10

(b) A helical spring is made from a wire of 6mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 MPa and modulus of rigidity

stress is 350 MPa and modulus of rigidity 8410 N/ mm^2, find the axial load which the spring can carry and the deflection per active turn. 5

6. Ajournal bearing is to be designed for a centrifugal pump for the following data: Load on the journal = 12 IN', Diameter ofthe journal = 75 mm; Speed = 1440 r.p.m; Atmospheric temperature of the oil = 16^0C; Operating temperature of the oil = 60^0C ; Abšolute viscosity of oil at 60^0C 0.023 kg / m—s. Give a systematic design ofthe bearing. 15

Unit-IV

7 Design a cast iron piston for a single acting four sfroke engine for the following data: Cylinder bore 100 mm; Stroke = 125 mm; Maximum gas pressure = 5 N/ mm^2 ; Indicated mean effective pressure = 0.75 N/ mm^2; Mechanical efficiency = 80%; Fuel consumption = 0.15 kg per brake power per hour, Higher calorific value of fuel = 42x 10^3 kJ/kg; Speed = 2000 r.p.m. Any other data required for the design may be assumed. 15

8 A single cylinder double acting steam engine delivers 185 kW at

100 r.p.m. The maximum fluctuation ofenergy per revolution is 15 percent ofthe energy developed per revolution. The speed variation is limited to 1 percent either way from the mean. The mean diameter ofthe rim is 2.4 m. Design and draw two views ofthe flywheel. 5

	B. Tech. VIth Semester Mechanical Engineering						
ME-312N	**Refrigeration and Air Conditioning Lab**						
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Practical**	**Total**	**Time (Hrs.)**
-	**-**	**2**	**-**	**40**	**60**	**100**	**3**
Purpose	To make students understand about the applications of refrigeration and Air-conditioning.						
	Course Outcomes:						
CO1	To understand about the basics and working principle of water cooler.						
CO2	Identify the different cycle of operation in air-conditioning						
CO3	To analyze the humidity measurement and its importance in air-conditioning						
CO4	To learn about the various control devices and parts of refrigeration and air-conditioning systems						

List of Experiments

2. To study and perform experiment on basic vapour compression Refrigeration Cycle.
3. To study and perform experiment on Solar Air-conditioner based on vapour absorption cycle.
4. To find COP of water cooler.
5. To study and perform experiments on compound compression and multi-load systems.
6. To study and perform experiment on vapour absorption apparatus.
7. Perform the experiment & calculate various performance parameters on a blower apparatus.
8. To find the performance parameter of cooling tower.
9. To study various components in room air conditioner.
10. To find RH of atmospheric air by using Sling Psychrometer.
11. To find performance of a refrigeration test rig system by using different expansion devices.
12. To study different control devices of a refrigeration system.
13. To find the performance parameters of Ice Plant.

Note: Any 8 experiments from the above list and other 2 from others (developed by institute) are required to be performed by students in the laboratory.

	B. Tech. VIth Semester Mechanical Engineering						
ME-314N	**TRIBOLOGY & MECHANICAL VIBRATION LAB**						
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Practical**	**Total**	**Time (Hrs.)**
-	**-**	**2**	**-**	**40**	**60**	**100**	**3**
Purpose:	To make the students understand about the tribological properties of specimen and principles of vibration.						
	Course outcomes:						
CO 1	To understand the concept of sliding and abrasive wear using wear and friction monitoring apparatus and dry abrasion tester.						
CO 2	To measure the extreme pressure properties of a lubricant using four ball tester.						
CO 3	To study the concept of free and forced vibration for a spring mass system and determine the natural frequency.						

LIST OF EXPERIMENTS:

1. To study undamped free vibrations of equivalent spring mass system and determine the natural frequency.
2. To study the free vibration of system for different damper settings. Draw decay curve and determine the log decrement and damping factor. Find also the natural frequency.
3. To study the torsional vibration of a single rotor shaft system and determine the natural frequency.
4. To determine the radius of gyration of given bar using bifilar suspension.
5. To verify the dunker ley's rule.
6. To study the forced vibration of system with damping. Load magnification factor vs. Frequency and phase angle vs frequency curves. Also determine the damping factor.
7. To determine the two frequencies of torsional spring type double pendulum & compare them with theoretical values.
8. To determine the radius of gyration of a compound pendulum.
9. To determine the radius of gyration of disc using trifilar suspension.
10. To determine the wear rate, friction force and coefficient of friction of a metallic pin/ball by using wear and friction monitor apparatus.
11. To determine abrasion index of a material with the help of dry abrasion test rig.
12. To evaluate the wear and extreme pressure properties of a lubricating oil by using four ball tester.

Note: Any 8 experiments from the above list and other 2 from others (developed by institute) are required to be performed by students in the laboratory.

	B. Tech. VIth Semester Mechanical Engineering						
ME-316N	**COMPUTER AIDED DESIGN AND MANUFACTURING LAB**						
Lecture	**Tutorial**	**Practical**	**Theory**	**Sessional**	**Practical**	**Total**	**Time (Hrs.)**
-	**-**	**2**	**-**	**40**	**60**	**100**	**3**
Purpose	The lab empowers the students to know about the computer aided manufacturing by using CAD						
	Course Outcomes						
CO1	Student gets aware about the 2D drawing and modelling.						
CO 2	Student knows how to use 3D software in part designing.						
CO 3	To know about the assembly and aware about the G codes and M codes.						
CO 4	Students will aware about the NC part programming and OPTIZE method.						

List of experiments

1 To study the 2 dimensional drawing, orthographic views, front view, top view and side view.
2 To study the wireframe, surface and solid modelling.
3 Draw the part drawing of product 1 using any 3D software.
4 Draw the part drawing of product 2 using any 3D software.
5 Make assembly by using any 3D software.
6 To study the G codes and M codes.
7 Write a NC program for milling operation.
8 Write a NC program for drilling operation.
9 Write a NC program for turning operation.
10 To study the optize method.

Note: Any 8 experiments from the above list and other 2 from others (developed by institute) are required to be performed by students in the laboratory. Product 1 and Product 2 must be based on ME 308N.