

Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title: Elements of Mechanical Engineering Science		Course Code:15MC31T
Mode (L:T:P) : 4:0:0	Credits:4	Core/ Elective: Core
Type of Course: Lectures & Student Activities		Total Contact Hours: 52
CIE= 25 Marks		SEE= 100 Marks

Prerequisites: Knowledge of Mathematics and Applied Science

Course Objectives: Understand the kinematics of Mechanisms, Power Transmission Systems, Strength Analysis of materials, Basic and Applied Thermodynamics.

Course Outcome: At the end of the semester, the students will be able to

1. Understand concepts of kinematic mechanisms
2. Know different types of systems available for power transmission
3. Understand the effect of various loads and induced stress and strain in the materials
4. Understand the effect of bending in beams
5. Understand thermodynamic processes and cycles,
6. Know the working of refrigerators, IC engines and air compressors

Course Outcome		Cognitive level	Linked with PO	Teaching Hours
CO1	Understand concepts of kinematic mechanisms.	<i>R/U</i>	1,2	6
CO2	Know different types of systems available for power transmission	<i>R/U/A</i>	1,2	6
CO3	Understand the effect of various loads and induced stress and strain in the materials	<i>U/A</i>	1,2	10
CO4	Understand the effect of bending in beams	<i>U/A</i>	1,2	10
CO5	Understand thermodynamic processes and cycles,	<i>R/U/A</i>	1,2	12
CO6	Know the working of refrigerators, IC engines and air compressors	<i>U</i>	1,2	08
		Total sessions		52

Legend: R; Remember, U: Understand A: Application

Mapping Of Course Outcomes with Program Outcomes

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Elements of Mechanical Engineering Science	3	3	-	-	-	-	-	-	-	-

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.

If $\geq 40\%$ of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3

If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2

If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1

If $< 5\%$ of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

Course Content and Weightage For SEE

Unit No	Unit Name	CO	Hour	Marks allocated for different Cognitive level Questions			Marks weightage (%)
				R	U	A	
1	Kinematic Mechanisms	1	6	05	15	-	13.79
2	Power Transmission System	2	6	05	05	10	13.79
3	Simple stresses and strains	3	10	-	10	15	17.24
4	Bending of Beams	4	10	-	10	15	17.24
5	Thermodynamic Cycles	5	12	05	10	15	20.69
6	Applied Thermodynamics	6	08	-	25	-	17.24
	Total		52	145 Marks			100

Contents

Unit-I

Kinematic Mechanisms

Kinematic link, kinematic pair, kinematic chain, Structure, machine, mechanism, their differences , inversion of mechanism, inversions of four bar chain, single slider crank chain and its inversion, double slider crank chain and its inversion.

6 Hours

Unit-II

Power Transmission System

Classification of power transmission system, power transmission by open belt drive and closed belt drive, velocity ratio and simple problems on velocity ratio, creep and slip in belt drive, power transmission by rope, chain and gear drives, types of gears: spur gear, bevel gear ,helical gear and rack and pinion, simple and compound gear trains.

6 Hours

Unit-III

Simple Stresses and strain

Stress, Strain, Types of stresses-tensile stress, compressive stress and shear stress, Hooke's Law, simple problems on above.

10 Hours

Unit-IV

Bending of Beams

Types of Load-Concentrated Load, Uniformly Distributed and Uniformly Varying Load. Shear Force, bending , sign conventions, SF and BM diagram for simply supported and cantilever beam for Concentrated Load, Uniformly Distributed and Uniformly Varying Load, simple problems on these

10 Hours

Unit-V

Thermodynamic Cycles

Laws of thermodynamics – first, second and zeroth law, perfect gas, gas laws, general gas equation, specific heats, thermodynamic processes - constant volume process, constant pressure process, isothermal process, adiabatic process, polytropic process, carnot cycle, otto cycle and diesel cycle (efficiency equation without derivation). Simple problems on efficiency of carnot and otto cycle

12 Hours

Unit-VI

Applied Thermodynamics

Working principle of 4 stroke petrol engines, 4 stroke diesel engine, 2 stroke petrol engine and 2 stroke diesel engine, working principle of vapour compression and vapour absorption refrigeration system, concept of summer air conditioning, winter air conditioning and all year air conditioning system

8 Hours

References:

- 1: Theory of Machines by, R.S.Khurmi, S Chand and company
- 2: Strength of materials by, R.S.Khurmi, S .Chand and company
- 3: Thermal engineering by R.S.Khurmi, S .Chand and company
- 4:Theory of Machines by S.S Rathan, Tata MacGraw hill publications, New Delhi.

e-Reference:

<http://freevidelectures.com/Course/2359/Kinematics-of-Machines#>
<http://www.learnerstv.com/video/Free-video-Lecture-2304-Engineering.htm#>
<https://en.wikipedia.org/?title=Kinematics>
<http://www.ignou.ac.in/upload/Unit-3-56.pdf>
<http://web.aeromech.usyd.edu.au/AMME2301/Documents/Chapter02.pdf>
https://www.youtube.com/watch?v=Hd8w_7s_78A
<http://bendingmomentdiagram.com/tutorials/calculation-shear-force/#>
<http://www.tutorvista.com/content/physics/physics-iii/heat-and-thermodynamics/thermodynamic-processes.php>
<http://www.tezu.ernet.in/sae/Download/Icengine.pdf>
<http://freevidelectures.com/Course/2372/Refrigeration-and-Air-Conditioning/1>

Student Activity

Activity No	Description of the Student Activity
1	Take a photo of a actual kinematic mechanism, prepare, explain and submit a report of 2 to 3 pages in handwritten form
2	Go to nearest vehicle garage/service station, get a used/replaced transmission element , prepare drawing of it, explain and submit a report of 2 to 3 pages in handwritten form
3	Take a photo of a actual Structural member/building/mechanism subjected to tensile or Compression or Bending or combined loads , prepare, explain and submit a report of 2 to 3 pages in handwritten form
4	Take a photo of a engine used in any automobile, prepare, explain and submit a report of 2 to 3 pages in handwritten form

Note:

1. Group of max four students should do any one of the above activity or any other similar activity related to the course COs and get it approved from concerned Teacher and HOD.
2. No group should have activity repeated or similar
3. Teacher should ensure activities by group must cover all Cos
4. Teacher should asses every student by using suitable **Rubrics** approved by HOD

Rubrics

Dimension	Exemplary	Accomplished	Developing	Beginning	Roll No. of the Student				
	5/4	3	2	1	1	2	3	4	5
Organization	Information presented in logical, interesting sequence	Information in logical sequence	Difficult to follow presentation-- student jumps around	Cannot understand presentation-- no sequence of information	Ex: 2				
Subject Knowledge	Demonstrates full knowledge by answering all class questions with explanations and	At ease with expected answers to questions but does not elaborate	Uncomfortable with information and is able to answer only rudimentary questions	Does not have a grasp of the information. Cannot answer questions about subject	3				

	elaborations								
Graphics	Explain and reinforce screen text and presentation	Relate to text and presentation	Occasionally uses graphics that rarely support text and presentation	Uses superfluous graphics or no graphics	4				
Oral Presentation	Maintains eye contact and pronounces all terms precisely. All audience members can hear	Maintains eye contact most of the time and pronounces most words correctly. Most audience members can hear presentation	Occasionally uses eye contact, mostly reading presentation, and incorrectly pronounces terms. Audience members have difficulty hearing	Reads with no eye contact and incorrectly pronounces terms. Speaks too quietly	5				
Total Score=2+3+4+5=14/4=3.5=4									

Institutional Activity

Activity No	Description of the Institutional Activity
1	Organise seminar, workshop, lecture from eminent person in the following domain: a) Recent trends in automobile technology b) Modern trends in refrigeration and air conditioning c) Industrial safety b) Impact of refrigerants usage on environment c) Effect of automobile pollution (Euro and Bharat norms) d) Design for safety e) Role of professional bodies in manufacturing such as institute of engineers.
2	Organise nearby industrial visit
3	Motivate student to take case study on kinematics, power transmission and thermodynamic system to inculcate self and continuous learning

Course Assessment Pattern

Particulars			Max Marks	Evidence	Course outcomes
Direct Assessment	CIE	Three test (Average of three tests)	20	Blue books	1,2,3,4,5,6
		Student Activity	05	Student Activity Sheets	1,2,3,4,5,6
	SEE	End of the course	100	Answer scripts at BTE	1,2,3,4,5,6
Indirect Assessment	Student Feedback on course	Middle of the course		Feedback forms	1, 2&3
		End of the course		Feedback forms	1,2,3, 4, 5&6

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

FORMAT OF I A TEST QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks		
Ex: I test/6 th week of sem 10-11 Am	I/II SEM		20		
	Year:				
Name of Course coordinator : CO's: _____			Units: __		
Question no	Question	MARKS	CL	CO	PO
1					
2					
3					
4					

Note: Internal Choice may be given in each CO at the same cognitive level (CL).

Model Question Paper (CIE)

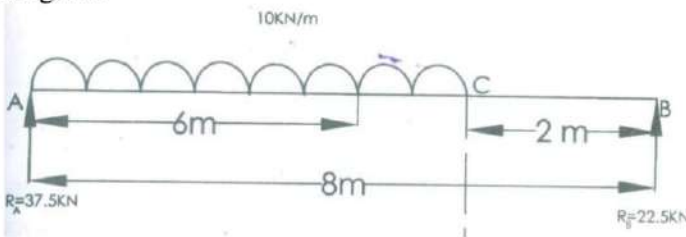
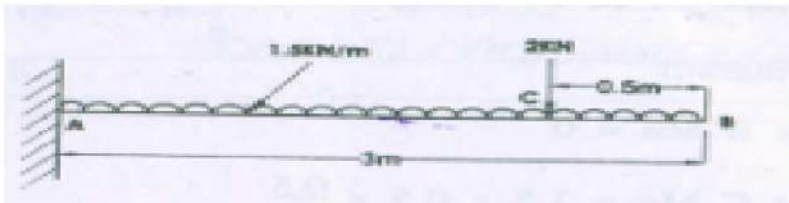
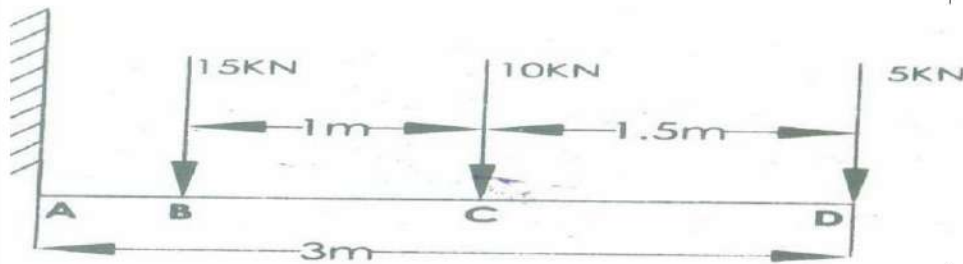
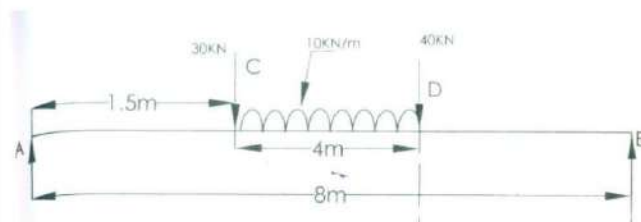
Date and Time	Semester	Course	Max Marks	
2 Test(10 th weak of sem) 10-11 Am	III SEM	Elements of Mechanical Engineering Science	20	
	Year: 2015-16	Course code:15MC31T		
Name of Course coordinator : All questions carries equal marks			Units:3,4 CO: 3,4	
Question No	Question	CL	CO	PO
1	Explain bulk modulus, modulus of rigidity and young's modulus OR Explain tensile and shear stress	U	3	1,2
2	A steel wire 2m long and 3mm in diameter is extended by 0.75mm when a weight W is suspended from the wire. If the same weight is suspended from a brass wire 2.5m long and 2mm diameter, it is elongated by 4.64mm. determining the modulus of elasticity of brass if the tough steel is $2 \times 10^5 \text{ kN/mm}^2$. OR A rod of cross sectional area 15mmx15mm and 1m long is subjected to a compressive load of 22.5kN. calculate the stress and decrease in length if $E=200 \text{ GN/mm}^2$	A	3	1,2
3	A simply supported beam of length 8m carries a UDL of 10kN/m for a distance of 6m from left support as shown in fig. Draw BM and SF diagram  OR A cantilever of length 2.5mt carries a UDL of 2kN/mt for a length of 2m from free end and a point load of 2kN at the free end as shown fig draw SF and BM diagram. 	A	4	1,2
4	A cantilever beam of length 3mt is subjected to a point load as shown in	A	4	1,2

fig. Draw SF and BM diagram



OR

A simply supported beam of length 8m carries the UDL at two point loads as shown in the fig. Draw SF and BM diagram



Model Question Paper
III Semester Diploma in Mechatronics Engineering
Elements of Mechanical Engineering Science

Instructions: Answer any six questions from part A and Seven full questions from part B

PART-A

Answer any six questions.

5X6=30 marks

1. Define kinematic link and kinematic pairs with examples
2. Explain working of scotch yoke mechanism
3. List advantages and disadvantages of V belt drive over flat belt drive
4. Explain the concept of creep in belt drive
5. Explain bulk modulus, modulus of rigidity and young's modulus
6. Explain sign convention in BM and SF in beams
7. Define system, boundary and surrounding
8. Explain constant volume process with pv diagram and write equation for workdone, change in internal energy and heat supplied
9. Explain ton of refrigeration and COP of refrigeration

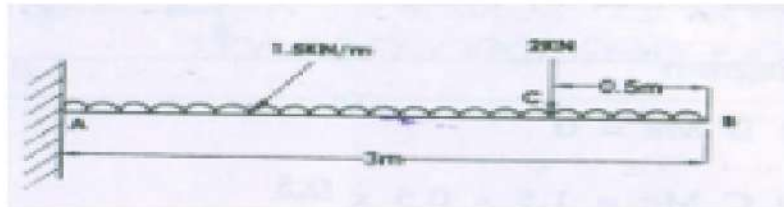
PART- B

Answer any seven full questions.

10X7=70M

1. a) Explain with neat sketch of crank and slotted lever quick return motion mechanism with its application. **6m**
b) Explain quadric cycle chain **4m**
- 2.a) In a open belt drive system, the diameter of the driving pulley is 200mm and of the driven pulley is 100mm. If the driving pulley is rotating at a speed of 300rpm, determine the speed of the driven pulley and velocity ratio **6m**
b) Explain with sketch simple and compound gear trains with applications **4m**
- 3 a) Explain tensile and compressive stress **4m**
b) A steel wire 2m long and 3mm in diameter is extended by 0.75mm when a weight W is suspended from the wire. If the same weight is suspended from a brass wire, 2.5m long and 2mm diameter, it is elongated by 4.64mm. determining the modulus of elasticity of brass if the tough steel is $2 \times 10^5 \text{ kN/mm}^2$ **6m**
- 4 a) Explain Hooks law with stress strain diagram for ductile **4m**

- b) A steel bar is 900mm long, its two ends are 40mm and 30mm in diameter and length of each rod is 200mm. The middle portion of the bar is 15mm in diameter and 500 mm long. If the bar is subjected to a axial load of 15kN, find its extension **6 m**
- 5 a) A cantilever of length 2.5mt carries a UDL of 2kN/mt for a length of 2mt from free end and a point load of 2kN at the free end as shown fig draw SF and BM diagram.

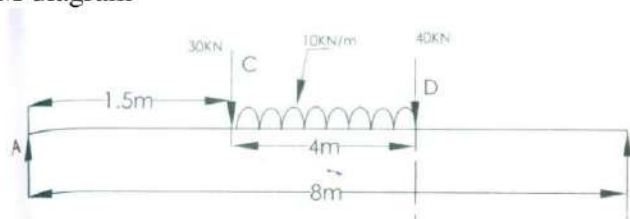


6m

- b) Explain bending equation

4m

6. A simply supported beam of length 8m carries the UDL at two point loads as shown in the fig. Draw SF and BM diagram



6m

- b) Explain the concept of Neutral axis

4m

7. a) A carnot cycle operates between the temperatures 250 deg c and 30 deg c. What is the efficiency of the engine **5m**
 b) Explain otto cycle with pv diagram and write equation for efficiency **5m**
8. a) Find the efficiency of an otto engine with compression ratio of 6.25 and adiabatic index 1.41 **5m**
 b) Explain diesel cycle with pv diagram and write equation for efficiency **5m**
9. a) With a neat sketch explain working of summer air conditioning **5m**
 b) With a neat sketch explain working of 4 stroke diesel engine **5m**
- 10 a) with a neat sketch explain working of vapour compression refrigeration system **6m**
 b) Explain ton of refrigeration and COP of refrigeration **4m**

Model Question Bank
III Semester Diploma in Mechatronics Engineering
Elements of Mechanical Engineering Science

Unit -1
Kinematic Mechanisms
Cognitive level-Remember

1. Define kinematic link and kinematic pairs with examples
2. Define kinematic pair and kinematic chain with examples
3. Define Machine and Mechanism with examples
4. Define Machine and Structure with examples

Cognitive level-Understanding

1. Explain types of links
2. Differentiate between structure and machine
3. Explain machine and mechanism with examples
4. Describe inversion of mechanism with example
5. Explain quadric cycle chain
6. Explain beam engine(Crank and lever mechanism)
7. Explain with sketch coupling rod of a locomotive
8. illustrate slider crank chain
9. Describe the working of pendulum pump or bull engine
10. Describe the working of oscillating cylinder engine
11. Explain working of elliptical trammel
12. Explain working of scotch yoke mechanism
13. Explain working of Oldham coupling
14. Explain with neat sketch of crank and slotted lever quick return motion mechanism with its application.
15. Explain with examples any two types of constrained motion
16. Explain with neat sketch any two inversions of four bar chain
17. Explain with neat any two types of single slider crank chain
18. Explain with neat any two types of double slider crank chain

Unit-II
Power Transmission System
Cognitive level-Remembering

1. List advantages and disadvantages of V belt drive over flat belt drive
2. Express power transmitted by belt in terms of tensions, Velocity of the belt and work done per second
3. List merits and demerits of chain drive
4. List merits and demerits of gear drive

5. List merits and demerits of spur gear drive with its applications
6. List the merits and demerits of bevel gear drive with its applications
7. List merits and demerits of helical drive with its applications
8. List merits and demerits of rack and pinion drive with its application

Cognitive level-Understanding

1. Explain open belt drive with its application
2. Explain cross belt drive with its application
3. Illustrate working of fast and loose pulley drive
4. Explain the concept of creep in belt drive
5. Illustrate the working of cone pulley drive
6. Explain the slip and its effect in belt drive
7. Explain open belt drive and twist belt drive with sketch
8. Explain compound belt drive and concept of slip with sketch
9. Explain with sketch cross section, working, advantages and disadvantages of V-belt drive
10. Explain with sketch simple and compound gear trains with applications

Cognitive level-Application

1. In a open belt drive system, the diameter of the driving pulley is 200mm and of the driven pulley is 100mm. If the driving pulley is rotating at a speed of 300rpm, determine the speed of the driven pulley and velocity ratio
2. If the diameter of the driving and driven is 350mm and 150mm respectively, and driving is running at a speed of 600rpm. Also if the percentage slip on driving side is 3% and driven is 5% find the speed of driven pulley

Unit-III

Simple stresses and strains

Cognitive level-Understanding

1. Explain the terms stress and strain
2. Explain the significance of young's modulus
3. Explain tensile and compressive stress
4. Explain compressive stress and shear stress
5. Explain tensile and shear stress
6. Explain Hooks law with stress strain diagram for ductile and brittle material
7. Explain bulk modulus, modulus of rigidity and young's modulus

Cognitive level-Application

1. A square steel rod 20mmx20mm in section is to carry an axial compressive load of 100kN. Calculate the shortening in a length of 50mm. Take $E=2.14 \times 10^8 \text{ kN/m}^2$.
2. The following observations were made during a tensile test on a mild steel specimen 40mm in diameter and 200mm long. Elongation with 40kN load is 0.0304mm, yield load 161kN, maximum load 242kN, length of a specimen at fracture 249mm. Determine young's modulus, yield point stress, ultimate stress and percentage elongation.
3. A steel wire 2m long and 3mm in diameter is extended by 0.75mm when a weight W is suspended from the wire. If the same weight is suspended from a brass wire, 2.5m long and 2mm diameter, it is elongated by 4.64mm. determine the modulus of elasticity of brass if the tough steel is $2 \times 10^5 \text{ kN/mm}^2$
4. A steel bar is 900mm long, its two ends are 40mm and 30mm in diameter and length of each rod is 200mm. The middle portion of the bar is 15mm in diameter and 500 mm long. If the bar is subjected to a axial load of 15kN, find its extension.
5. A rod of diameter 15mm and 50mm long is subjected to a tensile load of 25kN. The modulus of elasticity for steel rod may be taken as 200 kN/mm^2 . Find the stress, strain and elongation of the bar.
6. A rod of cross sectional area 15mmx15mm and 1m long is subjected to a compressive load of 22.5kN. calculate the stress and decrease in length if $E=200 \text{ GN/mm}^2$
7. Determine the diameter of a metal wire subjected to a load of 1kN, developing a stress of 20 N/mm^2 . if $E=1 \times 10^5 \text{ N/mm}^2$ for the wire, what will be the extension over a length of 5m.

Unit-IV

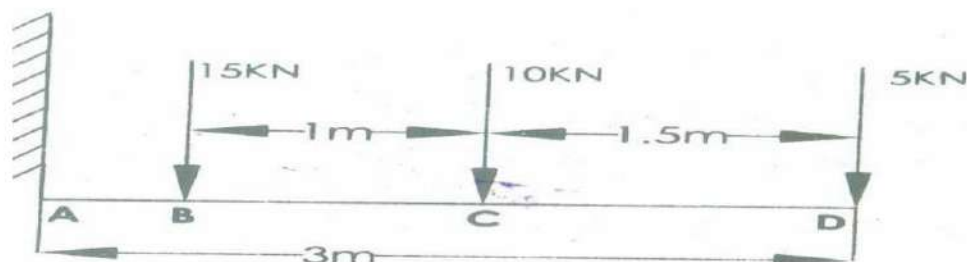
Bending of Beams

Cognitive level-Understanding

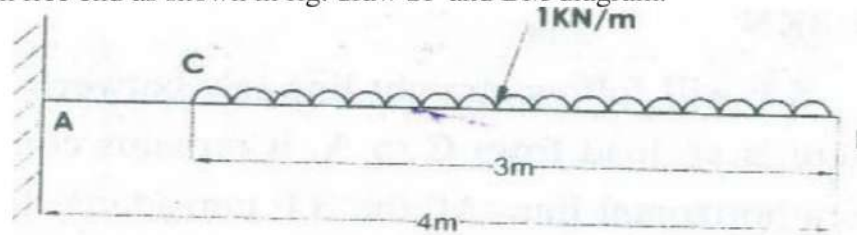
1. Explain bending equation
2. Explain SFD and BMD
3. Explain the concept of Neutral axis

Cognitive level-Application

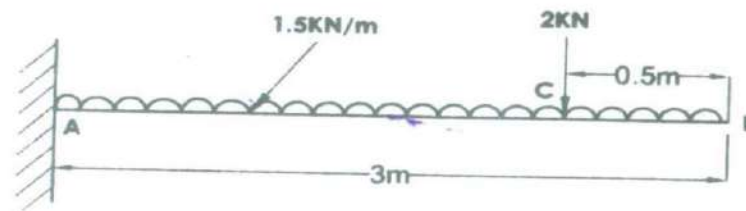
1. A cantilever beam of length 3mt is subjected to a point load as shown in fig. Draw SF and BM diagram.



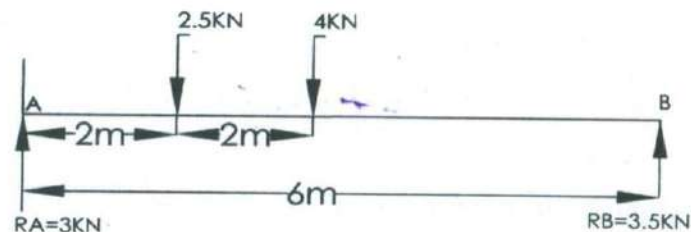
2. A cantilever beam of length 4m carries a UDL of 1kN/m for a length of 3m from free end as shown in fig. draw SF and BM diagram.



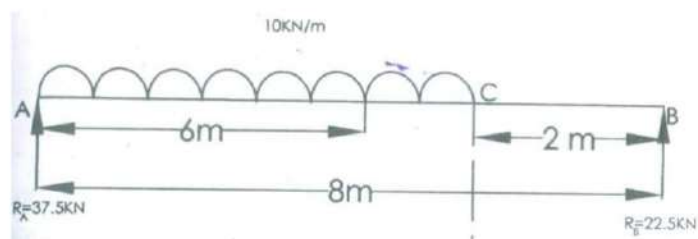
3. A cantilever of length 2.5m carries a UDL of 2kN/m for a length of 2m from free end and a point load of 2kN at the free end as shown fig draw SF and BM diagram.



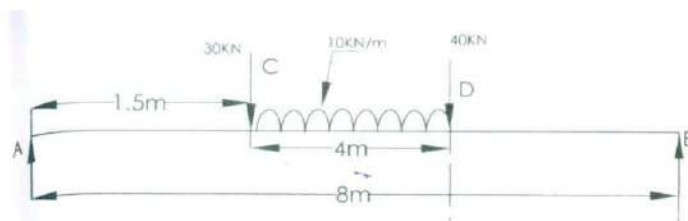
4. A simply supported beam of length 6m carries a point load of 2.5kN and 4kN at a distance of 2m and 4m from left support as shown in fig draw SF and BM diagram.



5. A simply supported beam of length 8m carries a UDL of 10kN/m for a distance of 6m from left support as shown in fig. Draw BM and SF diagram



6. A simply supported beam of length 8m carries the UDL at two point loads as shown in the fig. Draw SF and BM diagram



Unit-V

Thermodynamic Cycles

Cognitive level-Remembering

1. Define system, boundary and surrounding
2. Define law's of thermodynamics
3. Define first and second law of thermodynamics
4. Define zeroth law and second law of thermodynamics
5. Define first and zeroth law of thermodynamics
6. State Boyle's law and charle's law
7. Define gas constant and Universal gas constant with its value
8. Define specific heats of gas at constant volume and constant pressure

Cognitive level-Understanding

1. Explain thermodynamic system
2. Explain thermal equilibrium with examples
3. With an example explain open and closed system
4. Explain general gas equation
5. Explain characteristic gas equation
6. Explain constant volume process with pv diagram and write equation for workdone, change in internal energy and heat supplied.
7. Explain constant temperature process with pv diagram and write equation for workdone, change in internal energy and heat supplied
8. Explain adiabatic process with pv diagram and write equation for workdone, change in internal energy and heat supplied
9. Explain polytropic process with pv diagram and write equation for workdone, change in internal energy and heat supplied.
10. Explain carnot cycle with pv diagram and write equation for efficiency
11. Explain otto cycle with pv diagram and write equation for efficiency
12. Explain diesel cycle with pv diagram and write equation for efficiency

Cognitive level-Application

1. A carnot cycle operates between the temperatures 250 deg c and 30 deg c. What is the efficiency of the engine
2. Find the efficiency of an otto engine with compression ratio of 6.25 and adiabatic index 1.41

Unit-VI
Applied Thermodynamics
Cognitive level-Understanding

1. With a neat sketch explain working of 4 stroke petrol engine
2. With a neat sketch explain working of 2 stroke petrol engine
3. With a neat sketch explain working of 4 stroke diesel engine
4. With a neat sketch explain working of 2 stroke diesel engine
5. Differentiate between petrol and diesel engine
6. Differentiate two and four stroke engine
7. Discuss the properties of a good refrigerant
8. Explain different refrigerants used in air conditioning system
9. Define ton of refrigeration and COP of refrigeration
10. With a neat sketch explain working of vapour compression refrigeration system
11. With a neat sketch explain working of vapour absorption refrigeration system
12. With a neat sketch explain working of summer air conditioning
13. With a neat sketch explain working of winter air conditioning
14. With a neat sketch explain working of all the year air conditioning