



**SARVAJANIK UNIVERSITY**  
**Sarvajani College of Engineering and Technology**  
**Bachelor of Technology**



**Mechanical Engineering**  
**B. Tech. Semester IV**

**Course Name: Kinematics and Theory of Machines**

**Course Code: BTME13403**

**Type of course: Professional Core Courses (PCC)**

**Prerequisite: None**

**Rationale of course:** The major objective of this course is to impart knowledge on various types of synthesis of mechanism and to understand the concept of friction and its application in screw jack, clutch and brake as well as to understand the terminology associated with transmission elements and its application to the field of mechanical engineering.

**Teaching and Examination Scheme:**

| TEACHING SCHEME |   |   |   | Theory Marks |     |     | Practical Marks |     | Total |
|-----------------|---|---|---|--------------|-----|-----|-----------------|-----|-------|
| L               | T | P | C | TEE          | CA1 | CA2 | TEP             | CA3 | 150   |
| 3               | 0 | 2 | 4 | 60           | 25  | 15  | 30              | 20  |       |

**CA1:** Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

| Sr. No. | Topics  | Teaching Hrs. | Module Weightage |
|---------|---|---------------|------------------|
| 1       | <b>Introduction:</b><br>Kinematics, theory of machine, fundamental units, scalars and vectors, laws of motion, force, resultant force, couple, inertia, torque, power, work, energy, collision of bodies, kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations; Lagrange's equation. Simple problems. | 2             | 5 %              |
| 2       | <b>Simple mechanisms and Inversions:</b><br>Kinematic link, machine and structure, kinematic pair, constrained motion, kinematic chain, joints in chain, mechanism, degree of freedom, mobility and range of movement-Kutzbach and Grubler's criterion, Grashof's criterion, inversion of mechanism, contemporary mechanism, Problems.                                      | 6             | 15 %             |



**SARVAJANIK UNIVERSITY**  
**Sarvajanik College of Engineering and Technology**  
**Bachelor of Technology**



| Sr. No. | Topics   | Teaching Hrs. | Module Weightage |
|---------|--|---------------|------------------|
| 3       | <p><b>Displacement, velocity and acceleration analysis of plane mechanisms and Synthesis in mechanisms:</b></p> <p>Space and body centrodes, dynamic analysis of linkages, instantaneous centre method, graphical and analytical velocity analysis of slider crank and four bar mechanism, instant centers of velocity, graphical and analytical acceleration analysis of slider crank and four bar mechanism, graphical velocity and acceleration analysis of quick return mechanisms , Problems.</p> <p><b>Synthesis:</b> synthesis of mechanism, function, path, and Motion Generation , precision points and angle relationships for function generation, three position graphical synthesis for motion and path generation , graphical approach for four link mechanisms, Problems.</p> | 7             | 15 %             |
| 4       | <p><b>Cams and follower:</b></p> <p>Types of cams and followers, nomenclature, description and analysis of follower motion, determine of basic dimensions and synthesis of cam profiles, graphical method, application of cams and followers, Problems.</p>  | 7             | 15 %             |
| 5       | <p><b>Friction and its application in screw jack , clutch and brake:</b></p> <p>Introduction to friction, law of friction, coefficient of friction, angle of repose, rolling friction, Types of brakes ,Friction application to belt-pulley, screw jack, Friction clutches (disc clutch, centrifugal clutch), mechanical brake (Shoe brakes, band brake, anti-lock braking system, Braking effect in vehicle), Problems.</p>   | 9             | 20 %             |
| 6       | <p><b>Belt, Ropes and Chains:</b></p> <p>Introduction to belt drives, velocity ratio, slip and creep of belt, pulley arrangement, length of belt, law of belting, continuously variable transmission, Rope drives, ratio of driving tension, Chain drives classification, power transmitting chains, length of chain, application of various transmission devices, Problems.</p>   | 7             | 15 %             |
| 7       | <p><b>Gears and Gear Trains:</b></p> <p>Gear terminology, Classification of gears, gear materials, law of gearing, tooth forms, length of path and arc of contact, contact ratio, interference and undercutting, Gear trains: Simple,</p>  | 7             | 15 %             |



**SARVAJANIK UNIVERSITY**  
**Sarvajanik College of Engineering and Technology**  
**Bachelor of Technology**



| Sr. No. | Topics   | Teaching Hrs. | Module Weightage |
|---------|--|---------------|------------------|
|         | compound, reverted and epicyclic gear trains, application of gear and gear trains, Problems. |               |                  |

**Percentage Distribution of Marks as per Bloom’s Taxonomy (Theory/Practical):**

| % Distribution of Marks |         |         |         |         |         |
|-------------------------|---------|---------|---------|---------|---------|
| R Level                 | U Level | A Level | N Level | E Level | C Level |
| 20                      | 25      | 40      | 15      | 0       | 0       |

**Legends: R:** Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels (**Revised Bloom’s Taxonomy**)

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**Reference Books:**

| Sr. No. | Title of book /article               | Author(s)                   | Publisher         | Publication year | Publication Edition |
|---------|--------------------------------------|-----------------------------|-------------------|------------------|---------------------|
| 1       | Theory of Machines                   | S S Rattan                  | Tata McGraw-Hill  | 2019             | 5 <sup>th</sup>     |
| 2       | Theory of Machines                   | Singh Sadhu                 | Pearson Education | 2011             | 3 <sup>rd</sup>     |
| 3       | Theory of Machines and Mechanisms    | Uicker J J Jr., Pennock G R | Oxford Press      | 2014             | 4 <sup>th</sup>     |
| 4       | Kinematics and Dynamics of Machinery | Norton R L                  | McGraw-Hill       | 2012             | 5 <sup>th</sup>     |
| 5       | Mechanism and Machine theory         | Ambekar A G                 | Prentice Hall     | 2007             | 1 <sup>st</sup>     |

**Course Outcome (CO’s):**

| Sr. No. | CO Statement<br>After learning this subject, students will be able to              | Marks % weightage |
|---------|--|-------------------|
| CO-1    | Identify various mechanism and correlate with practical application                | 20 %              |
| CO-2    | Analyze various mechanism with analytical and graphical method                     | 30 %              |
| CO-3    | Apply the concept of friction and its application in screw jack , clutch and brake | 20 %              |
| CO-4    | Illustrate the use of power transmission elements                                  | 30 %              |

**Mapping of CO’s with Program Outcomes (PO’s) and Program Specific Outcomes (PSO’s):**

|      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| CO-1 | 3    | 3    | 0    | 2    | 2    | 0    | 0    | 0    | 3    | 1     | 0     | 1     | 1     | 2     | 3     |



**SARVAJANIK UNIVERSITY**  
**Sarvajanic College of Engineering and Technology**  
**Bachelor of Technology**



|                   | PO 1      | PO 2      | PO 3     | PO 4     | PO 5     | PO 6     | PO 7     | PO 8     | PO 9     | PO 10    | PO 11    | PO 12    | PSO 1    | PSO 2    | PSO 3    |
|-------------------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| CO-2              | 2         | 3         | 0        | 1        | 0        | 0        | 0        | 0        | 2        | 1        | 0        | 1        | 1        | 3        | 0        |
| CO-3              | 3         | 2         | 0        | 0        | 0        | 0        | 0        | 0        | 2        | 1        | 0        | 1        | 1        | 2        | 1        |
| CO-4              | 2         | 2         | 0        | 1        | 0        | 0        | 0        | 0        | 2        | 1        | 0        | 1        | 1        | 2        | 1        |
| <b>Rationale*</b> | <b>10</b> | <b>10</b> | <b>0</b> | <b>4</b> | <b>2</b> | <b>0</b> | <b>0</b> | <b>0</b> | <b>9</b> | <b>4</b> | <b>0</b> | <b>4</b> | <b>4</b> | <b>9</b> | <b>5</b> |

**\*Rationale of CO-PO-PSO Mapping:** This course highly maps with PO 1, 2, 9 and PSO 2. It states that the course will develop engineering knowledge, problem analysis and team work. This course also focuses on design and analyze different mechanical systems.

### List of Experiments:

1. Demonstration of linkage mechanisms in CAD and simulate for motion outputs and study the relevant effects of mechanism and their inversions.
  - (a) Simple four bar mechanism
  - (b) Simple four bar mechanism with slider
  - (c) Simple six bar mechanism
  - (d) Quick return crank and slotted lever type mechanism used in shaping machine
2. Velocity analysis of slider crank mechanism using graphical method
3. Velocity analysis of crank & slotted lever mechanism using I centre method
4. Acceleration analysis of slider crank mechanism and crank & slotted lever mechanism using graphical method
5. To draw the Profile of a disc Cam operating with knife edge or flat faced follower
6. To draw the Profile of a disc Cam operating with roller follower
7. To draw the Profile of a disc Cam operating with oscillating type roller follower
8. To draw two meshed spur gears tooth profile of actual dimensions and tabulating its terminology

### Student Activities:

1. Identify number of links and pairs of the mechanisms given below.
  - a) Bicycle free wheel sprocket mechanism
  - b) Geneva mechanism
  - c) Ackerman's steering gear mechanism
  - d) Foot operated air pump mechanism
  - e) Any real life problem of your choice
2. Prepare a computer program in Python language of any one mechanism from listed in activity one to find out motion and angular output as per variable inputs (synthesis of mechanisms)
3. Disassemble a multi-plate clutch of two wheeler and measure dimensions. Draw neat sketch of assembly using real dimensions and prepare its bills of material.



**SARVAJANIK UNIVERSITY**  
**Sarvajanik College of Engineering and Technology**  
**Bachelor of Technology**



**Major Equipment:**

- Computational facilities
- Models of four bar link , inversion of four bar chain, Geneva drive, kinematic pair, reciprocating engine, oscillating cylinder, watt's, plate cam with flat face follower, reciprocating knife edge follower, roller oscillating follower , bicycle free wheel sprocket , foot operated air pump mechanism

**List of Open Source/learning website:**

- <https://nptel.ac.in/courses/112105268>
- <https://nptel.ac.in/courses/112104121>
- <https://www.vlab.co.in/broad-area-mechanical-engineering>
- <http://www.mechanisms.co/index.html>

**List of Open Source Software: Nil**