# BETHLAHEM INSTITUTE OF ENGINEERING
# KARUNGAL

## *Department of Mechanical Engineering*

## 2.6 COURSE PLAN

**Date:**

| | |
|---|---|
| **Staff** | **: D. GINU** |
| | **: B.E/ Mechanical Engineering** |
| **Course Code &Title** | **: CE3491 / Strength of Materials** |
| **Year / Semester** | **: II/04** |
| **No. of Credits** | **: 3** |

## 1. VISION & MISSION OF THE DEPARTMENT:

**VISION: -**

To become a center of learning by inculcating technical skills among the students in the field of Mechanical Engineering.

**MISSION:-**

To impart quality technical education by adopting learner-centric approach in order to empower the creativity and productivity among the students.

## 2. PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO1 : Our graduates will have successful professional careers in industry, government, academia and military as innovative engineers.

PEO2 : Our graduates will be successful in solving engineering problems associated with the lifecycle of mechanical systems.

PEO3 : Our graduates will continue to learn and advance their careers through activities such as participation in professional organizations, attainment of professional certification and seeking higher education.

PEO4 : Our graduates will be active members ready to serve the society locally and globally.

## 3. PROGRAM OUTCOMES (POS)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## 4. PROGRAM SPECIFIC OUTCOMES (PSOS):-

PSO1 : Employability: Students acquire technical and managerial skills that make them an employable graduate. Excellent compliance to function in multi-disciplinary environment, exhibiting good interpersonal and leadership skills with a high degree of professionalism.

PSO2 : Research: Students acquire theoretical background of each course so that they are capable of applying it for solving real-time (Physical) problems.

## 5. COURSE OUTCOMES

Students able to

CO1: concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes

CO2: Estimate load transferring mechanism in beams and stress distribution due to shearing force and bending moment.

CO3: Formulate the basic equation of torsion in designing of shafts and helical springs.

CO4: Explain the slope and deflection in beams using different methods.

CO5: Computing the thin and thick shells for applied pressures

## 6. MAPPING OF COS, POS& PSOS

| CO | PO | PO | PO | PO | PO | PO | PO | PO | PO | PO 10 | PO 11 | PO 12 | PSO1 | PSO | PSO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | 1 | 2 | 2 | 2 | - |
| CO 2 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - | - | - | 2 | 3 | 2 | - |
| CO 3 | 3 | 2 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | - | - |
| CO 4 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | 3 | 3 | - | 2 |
| CO 5 | 3 | 2 | 2 | 3 | 3 | - | - | - | - | 2 | - | - | 2 | - | 2 |

**JUSTIFICATION FOR CORELATION**

| Sl. No | Related POs | Justification |
|---|---|---|
| CO1 | PO1<br>PO2<br>PO3<br>PO4<br>PO5<br>PO11<br>PO12 | 1. Student will be able to write mathematical equations for fundamental engineering is associated.<br>2.Students will be able to review literature based on basic mechanism<br>3. Students can identify and analyze the problem in cam mechanism<br>4. Different Beam components are discussed and student will be able to use them in simulation tool<br>5. Students will be able to design basic beam force<br>11.Students will be able to apply the fundamental law of gearing<br>12. Lifelong learning for the balancing of mass is involved. |
| CO2 | PO1<br>PO2<br>PO3<br>PO4<br>PO5<br>PO6<br>PO12 | 1. Students can be able to understand for different mathematical model for different beam losses is analyzed.<br>2. Students can formulate the problem related to energy losses by mathematical equations.<br>3. Students will be able to design Gear and formulate the solution.<br>4. Students will be able to synthesis the information from force and provide conclusions.<br>5. Students will be able to design balancing systems which requires advanced tools which can deal with Beam domain<br>6. Students will be able to decode information effectively using vibration processing<br>12. Students will be able to design Beam knowledge of basic losses is must so it involves lifelong learning. |
| CO3 | PO1<br>PO2<br>PO3<br>PO4<br>PO5<br>PO12 | 1. Students will be able to understand how to torsion work.<br>2. Students will be able to choose proper source for link design and engineering science is involved in study of Beam sources.<br>3. Students will be able to understand how vibrator work.<br>4. Students will be able to give conclusions from Beam sources and detectors<br>5. Students gains the ability to identify, formulate and analyze engineering problem<br>12.Lifelong learning for different Beam sources in CAM is involved |
| CO4 | PO1<br>PO2<br>PO3<br>PO4<br>PO12 | 1. Student will be able to analyze different component characteristics by testing equipment<br>2.Student will be able to use different measuring equipment at different stage of link to analyze link performance<br>3. Student will be able to choose different component of link based on given parameters.<br>4.Student will be able to use different measuring equipment at different stage of link to analyze link performance<br>6.Students will be able to Implement social relevant projects using the basics of measurement concepts<br>12.Lifelong learning for different Mechanism is involved |

| | | |
|---|---|---|
| CO5 | PO1<br>PO2<br>PO3<br>PO4<br>PO5<br>PO10<br>PO12 | 1. Student will be able to design Beam by understanding basic component working.<br>2. It gives basic mathematics and engineering required to design a link<br>3.Student can design a basic link as per given specification<br>4. Beam components is explained so student can understand its characteristics and can use proper components in link design.<br>5. Students will be analyze various Beam networks used in various applications<br>10. Students will be able to design and prepare report, presentations about different Beam networks<br>12. Lifelong learning for designing an Beam is involved |

**JUSTIFICATION FOR CORELATION**

| Sl. No | Related POs | Justification |
|---|---|---|
| CO1 | PSO1<br>PSO2 | 1. Students will be able to understand basic components of Beam.<br>2. Various environmental issues can be reduced by designing Beam mechanism. |
| CO2 | PSO1<br>PSO2 | 1. Students will be able to understand different losses and thus can design link.<br>2. Considering the 'environment and society' the Beam losses are reduced |
| CO3 | PSO1 | 1.Diffrent Beam components are discussed and student will be able to use them in simulation tool |
| CO4 | PSO1<br>PSO3 | 1. Students are designing basic Beam using Beam software.<br>3.Students will be able to adapt with different recent techniques by studying Beam measurements |
| CO5 | PSO1<br>PSO3 | 1.Design and analysis of linear time invariant circuits is required for developing cost effective solutions<br>2. Students will be able to adapt with recent techniques by studying Beam networks |

## 7. PRE-REQUISITE

| Course with code | Brief Description |
|---|---|
| Engineering Physics (PH3151) | Should have skill to apply Static and dynamic forces acting on a body. |
| Engineering Mechanics (ME3351) | Should have knowledge about basic Mechanisms. |

## 8. COURSE DESCRIPTION

Theory of machines & mechanisms focuses on the study of relative motion between numerous machine components and the forces that act on them. The knowledge of this subject is very essential for an engineer in designing the various parts of a machine. Through our course you will learn the fundamental principles and technology of strength of machines.

## 9. LESSON PLAN

| Lecture No. | Topic(s) to be covered | Text / Ref. Book | Method (CTL, CL, ICT (FL), ICT (PPT) PL, RL, Seminar etc.) | Testing Method (Group Discussion, MCQ, Tutorial, Seminar, Oral/Written Test) | Course Outcomes (COs) | No. of Hours | Cumulative Hours |
|---|---|---|---|---|---|---|---|
| **UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS** | | | | | | | |
| 1 | Rigid bodies and deformable solids | T1 | PPT | Written Test, MCQ, Tutorial | | 1 | 1 |
| 2 | Tension, Compression and Shear Stresses | T1 | CTL | | | 1 | 2 |
| 3 | Deformation of simple and compound bars | T1 | ICT (FL) | | | 1 | 3 |
| 4 | Thermal stresses | T1 | CTL | | | 1 | 4 |
| 5 | Elastic constants | T1 | CTL | | | 1 | 5 |
| 6 | Volumertric strains | T1 | CTL | | | 1 | 6 |
| 7 | Stresses on inclined planes | T1 | FL | | | `1 | 7 |
| 8 | Principal stresses and principal planes | T1 | CTL | | | 1 | 8 |
| 9 | Mohr's circle of stress | T1 | EL | | | 1 | 9 |
| **UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM** | | | | | | | |
| 10 | Beams – Types | T2 | CTL | Written Test, MCQ, Tutorial | | 1 | 1 |
| 11 | Transverse loading on beams | T2 | CTL | | | 1 | 2 |
| 12 | Shear force and Bending moment in beams | T2 | CTL | | | 1 | 3 |
| 13 | Cantilever, Simply supported and over hanging beams | T2 | CTL | | | 1 | 4 |
| 14 | Theory of simple bending | T2 | CTL | | | 1 | 5 |
| 15 | Bending stress distribution | T2 | FL | | | 1 | 6 |
| 16 | Load carrying capacity | R1 | CTL | | | 1 | 7 |
| 17 | Proportioning of sections | R1 | RL | | | 1 | 8 |
| 18 | Flitched beams, Shear stress distribution | T2 | CTL | | | 1 | 9 |
| **UNIT III TORSION** | | | | | | | |
| 19 | Theory of Torsion | T2 | CTL | | | 1 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 20 | Stresses and Deformations in Solid and | T2 | CTL | Written Test, MCQ, Tutorial | | 1 | 2 |
| 21 | Combined bending moment and | T2 | FL | | | 1 | 3 |
| 22 | Power transmitted to shaft | T2 | CTL | | | 1 | 4 |
| 23 | Shaft in series and parallel | T2 | FL | | | 1 | 5 |
| 24 | Closed and Open Coiled helical springs | T2 | CTL | | | 1 | 6 |
| 25 | springs in series and parallel. | T2 | CTL | | | 1 | 7 |
| 26 | torsion of shafts | T2 | FL | | | 1 | 8 |
| 27 | Hollow Circular Shafts | T2 | CTL | | | 1 | 9 |
| **UNIT IV DEFLECTION OF BEAMS** | | | | | | | |
| 28 | Elastic curve | T2 | ICT (PPT) | Written Test, MCQ, Tutorial | | 1 | 1 |
| 29 | Governing differential equation | T2 | CTL | | | 1 | 2 |
| 30 | Double integration method | T2 | EL | | | 1 | 3 |
| 31 | Macaulay's method | T2 | EL | | | 1 | 4 |
| 32 | Area moment method | R1 | CTL | | | 1 | 5 |
| 33 | Inertia Torque D'Alembert's principle | T2 | CTL | | | 1 | 6 |
| 34 | Conjugate beam method for computation of slope | T2 | CTL | | | ` | 7 |
| 35 | deflection of determinant beams | T2 | EL | | | 1 | 8 |
| 36 | Two, Three and four members | T2 | CTL | | | 1 | 9 |
| **UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS** | | | | | | | |
| 37 | Stresses in thin cylindrical shell due to internal pressure | T2 | CTL | Written Test, MCQ, Tutorial | | 1 | 1 |
| 38 | circumferential and longitudinal stresses | T2 | CTL | | | 1 | 2 |
| 39 | Deformation in thin cylinders | T2 | RL | | | 1 | 3 |
| 40 | Spherical shells subjected to internal pressure | T2 | CTL | | | 1 | 4 |
| 41 | Deformation in spherical shells | T2 | CTL | | | 1 | 5 |
| 42 | Thick cylinders | T2 | RL | | | 1 | 6 |
| 43 | Lame's theory. | T2 | CTL | | | 1 | 7 |

[CTL-Chalk and Talk, PPT-Power Point Presentation, FL- Flipped Class, EL- Experiential Learning, RL- Research based Learning]

## 10. LIST OF TEXT BOOKS BY AU:

T1: Rajput R.K. “Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 7th edition, 2018. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014 (UNIT III)

T2: Rattan S.S., “Strength of Materials", Tata McGraw Hill Education Pvt .Ltd., New Delhi, 2017.

11. **REFERENCE BOOKS BY AU:**

R1: Singh. D.K., “Strength of Materials”, Ane Books Pvt Ltd., New Delhi, 2021.

R2: Egor P Popov, “Engineering Mechanics of Solids”, 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2015.

R3: Beer. F.P. & Johnston. E.R. “Mechanics of Materials”, Tata McGraw Hill, 8th Edition, New Delhi 2019.

R4: Vazirani. V.N, Ratwani. M.M, Duggal .S.K “Analysis of Structures: Analysis, Design and Detailing of Structures-Vol.1”, Khanna Publishers, New Delhi 2014

12. **OTHER RELATED BOOKS AVAILABLE IN OUR LIBRARY:**

O1. A Textbook of Strength of Materials” by R K Bansal

O2. Foundations of Materials” by S W Yuan

**13. WEB RESOURCES**

| Jnit | Topic | Web Link |
|---|---|---|
| I | Stress, Strain and Deformation Of Solids | https://toppersportal.com/buoyancy-and-floatation-notes/ |
| II | Transverse Loading on Beams and Stresses In Beam | https://pritamashutosh.wordpress.com/2014/02/06/flow-through-circular-conduits/ |
| III | Torsion | https://fluidfreak.wordpress.com/2014/05/03/rayleigh-method-pi-theorem/ |
| IV | Deflection of Beams | https://www.linquip.com/blog/what-is-francis-turbine/ |
| V | Thin Cylinders, Spheres and Thick Cylinders | https://theconstructor.org/practical-guide/reciprocating-pump-components-working-uses/2914/ |

**14. VIDEO RESOURCES**

| Sl. No | University | Website | Video Link |
|---|---|---|---|
| **V1** | **IIT Kanpur** | www.nptelvideos.com | https://nptel.ac.in/courses/112105269 |
| **V2** | **IIT Madras** | www.nptelvideos.com | https://nptel.ac.in/courses/112105269 |

## 15. ASSIGNMENTS

| Sl.No | COs | Topics |
|---|---|---|
| 1 | CO1 | Compression and Shear Stresses |
| | | Deformation of simple and compound bars |
| 2 | CO2 | transverse loading on beams |
| | | Shear force and Bending moment |
| 3 | CO3 | Shaft in series and parallel |
| | | springs in series and parallel |
| 4 | CO4 | Double integration method |
| | | Conjugate beam method for computation |
| 5 | CO5 | Spherical shells subjected to internal pressure |
| | | Lame's theory |

## 16. CONTENT BEYOND SYLLABUS

**Details of Content Beyond the syllabus for attaining COs/POs/PSOs:**

| Sl. No | Gap Identified | Contents/Activity to bridge the gap | Method of Implementation (Seminar / Guest Lecture/IV/Work shop etc.) | No. of Period | Mapping to COs | Mapping to POs | Mapping to PSOs |
|---|---|---|---|---|---|---|---|
| 1. | Open Coiled helical springs | Spheres and Thick Cylinders | Seminar | 1 | CO4 | PO7 | PSO2 |
| 2. | Flitched beams | Beams and Stresses In Beam | Seminar | 1 | CO5 | PO6 | PSO1 |

*Proof has to be retained for verification*

**JUSTIFICATION FOR CORRELATION**

| Contents/Activity to bridge the gap | Related COs, POs & PSOs | Justification |
|---|---|---|
| **1.** | CO4 | An abstract knowledge of analysis of Applied and Constrained Forces are required |
| | PO7 | Students will be able to function communicate effectively as an individual to accomplish the given task |
| | PSO2 | Students will be able to apply the knowledge of mathematics and science to solve various fundamental problems in Modal analysis |
| | CO5 | Design and application in Beam in Machine Elements |
| **2.** | PO6 | It involves complex processes so a design Bearings and lubrication concept. |
| | PSO1 | Students will be able able to identify the procedures and components |

## 17. JOURNALS LINK

| Sl.No | Journal Name | Publisher | Link |
|---|---|---|---|
| 1. | An International Journal of "Journal of Non-Newtonian Strength of Materials" | Elsevier | https://www.elsevier.com/journals/international-journal-of-heat-and-fluid-flow/0142-727X/guide-for-authors |
| 2. | International Journal of Strength of Materials | Science Direct | https://www.sciencedirect.com/science/article/pii/B9780124171312000107 |

**18 . ASSESSMENT METHODOLOGY**

| Assessment | Topic | CO | Marks |
|---|---|---|---|
| IAT-1 | Unit 1& Unit 2 | CO1<br>CO2 | 49<br>51 |
| IAT-2 | Unit 3 & Unit 4 | CO3<br>CO4 | 49<br>51 |
| Slip Test | Unit 5 | CO5 | 40 |
| Model Test | Unit 1- Unit 5 | CO1<br>CO2<br>CO3<br>CO4<br>CO5 | 17<br>17<br>17<br>17<br>32 |
| Assignment | Unit 1- Unit 5 | CO1<br>CO2<br>CO3<br>CO4<br>CO5 | 10<br>10<br>10<br>10<br>10 |

**Course In-charge** **Module Coordinator** **Academic Resource Cell Member**

**HoD** **Principal**