DEPARTMENT OF MECHANICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE PLAN – PART I			
Name of the programme and specialization	**B.Tech – Mechanical Engineering**		
Course Title	**Continuum Mechanics**		
Course Code	**MEPE30**	**No. of Credits**	**3**
Course Code of Pre-requisite subject(s)	**MEPC10 – Engineering Mechanics, Strength of Materials, Fluid Mechanics**		
Session	**January 2021**	**Section (if, applicable)**	**A & B**
Name of Faculty	**Dr.-Ing. Ashok Kumar Nallathambi**	**Department**	**Mechanical Engg.**
Email	**nashok@nitt.edu**	**Telephone No.**	**63835 01906**
Name of Course Coordinator	**Dr. M. Shahul Hameed**		
E-mail	hameed@nitt.edu	**Telephone No.**	
Course Type	**Program Elective**		

Syllabus (approved in BoS)

Tensor algebra: Scalar, Vector, second and higher order Tensors, Eigen values & vectors, Transformation of Tensors, Tensor valued functions, gradient operators and Integral theorems.

Kinematics: References and deformations configurations, Mapping and deformation gradients, material and spatial representations, Nanson's formula, Strain measures, Rotation & stretch tensors, rate of deformation.

Kinetics: Concept of stress, Cauchy's stress theorem, first and second Piola- Kirchoff's & Cauchy's stress tensors, Normal and shear stress, Extremal stress values, stress states.

Balance Principles: Mass conservation, Reynold's transport theorem, Momentum and energy balances in references and current configuration, Weak and strong forms of balance equation, Continuum thermodynamics, Clausius-Duhem inequality, Frame dependent and independent quantities, Objective rates.

Constitutive Modeling: Fluid and solid constitutive equations, generalized Hooke's law, material symmetry, visco elasticity, metal plasticity: Yield criteria, Flow rule, Hardening rule, loading & unloading conditions, multiplicative strain decomposition, rheological models.

COURSE OBJECTIVES	
1. To introduce basic tonsorial calculus for understanding continuum behavior of matters. 2. To familiarize the kinematics of continuum body deformation 3. To familiarize the configuration dependent stress and strain measures. 4. To strengthen the knowledge about the fundamental balance principles of continuum objects. 5.To establish a good foundation in constitutive modeling of solids.	
COURSE OUTCOMES (CO)	
Course Outcomes	**Aligned Programme Outcomes (PO)**
At the end of this course, the student will	
Understand the tensorial representation of physical quantifies	**1,2,5,8,10-12**
Understand the unified theory of continuum body such as fluids and solids.	**1,2,5,8,10-12**
Knowledge of stress and strain at a particular configuration on a material and spatial point	**1,2,5,6,10-12**
Understand the balance of mass, momentum, and energy balance using the tensorial representation	**1,2,4, 5,10-12**
Ability to perceive the constitutive modeling of materials	**1,2,3, 5,7,9-12**

COURSE PLAN – PART II

COURSE OVERVIEW

This course introduces the tensor algebra required for understanding the balance principles. The unified continuum concept will bring the common platform for the solid and fluids. The configurational dependent and independent physical parameters will be elucidated. Balance principles and material constitutive model will be discussed in detail. Classical plasticity will also be discussed.

COURSE TEACHING AND LEARNING ACTIVITIES

S.No.	Week/Contact Hours	Topic	Mode of Delivery
1	1st Week	Introduction of Tensors – first and second order tensors, scalar, vector, dyadic operations	MS Team with whiteboard
2	2nd Week	Indicial notations, tensor algebra, Cartesian tensor, Coordinate transformations, fundamental metric tensor	MS Team with whiteboard
3	3rd Week	Covariant and contravariant components, Vector and Tensor transformation, higher order tensors	MS Team with whiteboard

4	4th Week	Eigen values & vectors, Tensor valued functions, gradient operators and Integral theorems	MS Team with whiteboard
5	5th Week	Kinematics-1: References and deformations configurations, Mapping functions and deformation gradients, material and spatial representations	MS Team with whiteboard
6	6th Week	Kinematics-2: Material time derivate of spatial variables, different Strain measures	MS Team with whiteboard
7	7th Week	Kinematics-3: Nanson's formula, Rotation & stretch tensors, rate of deformation, Lie time derivatives	MS Team with whiteboard
8	8th Week	Kinetics-1: Concept of stress, Cauchy's stress theorem, first and second Piola-Kirchoff's & Cauchy's stress tensors	MS Team with whiteboard
9	9th Week	Kinetics-2: Extremal stress values, stress states, alternative stress measures	MS Team with whiteboard
10	10th Week	Mass conservation, Reynold's transport theorem, Momentum and energy balances in references and current configuration,	MS Team with whiteboard
11	11th Week	Weak and strong forms of balance equation, Continuum thermodynamics, Clausius-Duhem inequality	MS Team with whiteboard
12	12th Week	Frame dependent and independent quantities, Objective rates	MS Team with whiteboard
13	13th Week	Fluid and solid constitutive equations, generalized Hooke's law, material symmetry, visco elasticity	MS Team with whiteboard
14	14th Week	Metal plasticity: Yield criteria, Flow rule, Hardening rule, loading & unloading conditions	MS Team with whiteboard

COURSE ASSESSMENT METHODS (shall range from 4 to 6)

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	Cycle Test 1	5th week	1 hr 30 min	25
2	Cycle Test 2	10th week	1 hr 30 min	25

3	Assignments	Every 4 weeks	4	20
CPA	Compensation Assessment*	14th week	1 hr 30 min (syllabus – upto last week class teaching)	25
4	Final Assessment *	15th week	2 hours	30

***mandatory; refer to guidelines on page 4**

COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)

1. Feedback from the students during class committee meeting.
2. At the end of every cycle test, feedback will be obtained for the lecture improvement
3. End semester feedback on Course Outcomes.

COURSE POLICY (preferred mode of correspondence with students, compensation assessment policy to be specified)

MODE OF CORRESPONDENCE (email/ phone etc)

- Per Email (nashok@nitt.edu)
- Student hours: Monday to Saturday 15:000 – 18:00
  (during this time period, students can discuss about their doubts)
- WhatsApp 6383501906 or Mobile 95003 10739

COMPENSATION ASSESSMENT POLICY

Whomever missed the cycle test 1 or 2, can compensate with extra exam. Syllabus for the test should be the topics covered up to last week before the test.

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

- **At least 75% attendance in each course is mandatory.**
- **A maximum of 10% shall be allowed under On Duty (OD) category.**
- Students with **less than 65% of attendance** shall be prevented from writing the final assessment and **shall be awarded 'V' grade.**

ACADEMIC DISHONESTY & PLAGIARISM

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.
- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.

- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.

  The above policy against academic dishonesty shall be applicable for all the programmes.

ADDITIONAL INFORMATION

Recommended **Books** for reading

1. Nonlinear Solid Mechanics: A Continuum Approach for Engineering, Gerhard A. Holzapfel, Wiley Publications, ISBN: 978-0-471-82319-3, 2000.
2. Schaum's Outline of Continuum Mechanics, George E. Mase, McGraw Hill; First edition, ISBN: 978-9389691283
3. Computational Continuum Mechanics, Ahmed A. Shabana, Wiley; 3rd edition, ISBN: 978-1119293217, 2005.

4. An Introduction to Continuum Mechanics, J.N. Reddy, Cambridge University Press; 2nd edition, ISBN: 978-1316614204
5. Introduction to Continuum Mechanics, by W Michael Lai, David H. Rubin, Erhard Krempl, David Rubin, Butterworth-Heinemann; 4th edition, ISBN: 978-9380501581
6. Fundamentals of Continuum Mechanics, John W Rudnicki, Wiley, ISBN: 978-1-118-92767-0

7. Continuum Mechanics, A.J.M.Spencer, Dover Publications Inc. ISBN: 978-0486435947
8. Elasticity and plasticity of large deformations. Bertram, A., Springer-Verlag Berlin Heidelberg, 3rd Edition, 2012, ISBN: 978-3642246142.
9. Computational inelasticity. Vol. 7., Simo, Juan C., and Thomas JR Hughes, Springer Science & Business Media, 2013, ISBN: 978-1475771695.

10. Mysore N. L. Narasimhan, Principles of Continuum Mechanics, Wiley-Interscience, ISBN: 978-0471540007, 1992.
11. Fridtjov Irgens, Continuum mechanics, Springer, ISBN: 978-3-540-74297-5, 2008.
12. **C.S. Jog,** Continuum Mechanics: Volume 1: Foundations and Applications of Mechanics, Cambridge University Press, 978-1107091351, 2015

Course materials can be obtained from google classroom: swtzf5f
https://classroom.google.com/c/MjU3MDY3NjU4OTA3?cjc=swtzf5f

FOR APPROVAL

04/02/24		
Dr. Ashok Kumar Nallathambi	**Dr. M. Shahul Hameed**	**Dr. AR. Veerappan**
Course Faculty	**CC-Chairperson**	**HOD**

Guidelines:

a) The number of assessments for a course shall range from 4 to 6.

b) Every course shall have a final assessment on the entire syllabus with at least 30% weightage.

c) **One compensation assessment for absentees in assessments (other than final assessment) is mandatory. Only genuine cases of absence shall be considered.**

d) The passing minimum shall be as per the regulations.

B.Tech. Admitted in				P.G.
2018	2017	2016	2015	
35% or class average/2 whichever is greater.		Peak/3 or class average/2 whichever is lower		40%

e) Attendance policy and the policy on academic dishonesty & plagiarism by students are uniform for all the courses.

f) Absolute grading policy shall be incorporated if the number of students per course is less than 10.

g) Necessary care shall be taken to ensure that the course plan is reasonable and is objective.