AMIRKABIR
University of Technology

Theory of Concrete Plasticity
Spring 2019

COURSE DESCRIPTION:

With the present state of development of finite-element computer programs, the problem of modeling the mechanical behavior of concrete for use in analytical studies of reinforced concrete structures remains one of the most difficult challenges in the field of structural concrete engineering. The main objective of this course is to provide students with a rational basis of the advanced analysis of reinforced concrete members and structures through understanding of material and structural behavior. The subject will be approached by looking into some basic concepts and experimental facts concerning the stress and strain characteristics of concrete under biaxial and multiaxial stress states. Empirical equations for modulus and fracture strength are presented. Concrete elasticity and generalized failure and fracture criteria are discussed followed by a discussion of concrete plasticity with applications of finite-element analysis to concrete and reinforced concrete structures.

COURSE STAFF:

Instructor: Dr. Siamak Epackachi
Office: Building No. 1, Seventh story, Room No. 717
E-mail: epackachis@aut.ac.ir

Office hours: Tuesday15:00-16:00

TA: -
E-mail: -

CLASS SCHEDULE:

Lecture: Tue/Thu 13:30-15:00

REFERENCES:

Main references:

- Chen, Wai-Fah. *Plasticity in reinforced concrete*. J. Ross Publishing, 2007.
- Chen, Wai-Fah, and H. Zhang. *Structural plasticity: theory, problems, and CAE software*. New York: Springer-Verlag, 1991.
- Dunne, Fionn, and Nik Petrinic. *Introduction to computational plasticity*. Oxford University Press on Demand, 2005.

Additional references:

- Yu, Mao-Hong. Generalized plasticity. Springer Science & Business Media, 2006.
- de Souza Neto, Eduardo A., Djordje Peric, and David RJ Owen. Computational methods for plasticity: theory and applications. John Wiley & Sons, 2011.
- R. Hill, The mathematical theory of plasticity, Clarendon Press, 1950.
- W. Johnson, P. Mellor, Plasticity for mechanical engineers, D. Van Nost. Reinhold Co, 1962.
- A. Mendelsohn, Plasticity: Theory and Application, Mcmillan Publishing, 1968.
- L. Kachanov, Foundations of the theory of plasticity, North-Holland Publishing, 1971.

- W. Johnson, P. Mellor, Engineering Plasticity, D. Van Nost. Reinhold Co, 1973.
- J. Lubliner, Plasticity theory, Mcmillan Publishing Company, 1990 (revised: 2006).
- Vlado A. Lubarda, Elastoplasticity Theory, CRC Press, 2001.
- Han Chin Wu, Continuum Mechanics and Plasticity, CRC Press, 2004.
- D. Rees, Basic Engineering Plasticity, Butterworth-Heinemann, 2006.
- K. Hashiguchi, Elastoplasticity Theory, Springer, 2009
- J. Chakrabarty, Applied Plasticity, Springer, 2009.
- N. P. Nielsen, Limit Analysis and Concrete Plasticity. 3rd ed. New York, NY: CRC, 2010.

GRADING:

Assignments	30%
Final	40%
Project	30%

- Attendance at all lectures and recitations, and active participation is expected. The instructor regularly brings up questions and discussions during lecture time. Students are encouraged to volunteer in answering questions and participate in discussions.

- *Sustained effort starting today*: Come to class and recitations regularly. Pay attention in class without distractions through smartphones etc. Bring a scientific calculator and follow along with calculations in class.

- For the assignments, although students may consult with classmates, it is expected that solutions that are submitted, reflect the individual work of students.

- A significant part of engineering is written communication of laboratory work and analysis/design proposals. Heavy emphasis will be placed on clarity, organization and readability of your work. (a) All assignments must be submitted with no more than one problem per page. (b) Write your name, course and homework number on a cover sheet. (c) Staple pages together. (d) A clear and well-labeled **drawing** or **free body diagram** as appropriate *must* be presented with every problem. (e) Always use **units** everywhere in your work – a number without units makes no sense in engineering. (f) Show each step of the problem and clearly explain the logic being used. (g) Clearly box all final answers.

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Course Outlines:

- Introduction (1 week)
- Fundamentals of continuum mechanics (2 weeks)
- Elastic and plastic stress-strain relationships (2 weeks)
- Uni- and multi-axial behavior of concrete (1 week)
- Yield and Failure criteria of concrete (2 weeks)
- Stress- and strain-based plasticity models for concrete (3 weeks)
- Isotropic and anisotropic damage models for concrete (2 weeks)
- Combinations of stress- and strain-based plasticity models with isotropic and anisotropic damage models for concrete (2 weeks)
- Limit analysis of concrete structures (1 week)
- Implementation of plasticity formulations in numerical analysis of concrete structures (1 week)