SECOND SEMESTER 2020-2021
COURSE HANDOUT

Date: 11.03.2021

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **CE G562**
Course Title : **Advanced Concrete Technology**
Instructor-in-Charge : **Dr. Mukund Lahoti**

1. Objective of the course and Course Description:

This course aims to provide comprehensive scientific insight of concrete ingredients and their influence on hydration kinetics. At the end of this course, the students will able to apply their knowledge in modern concrete practices. The course will provide in-depth analysis into the composition and relevant chemistry of concrete constituents. This course will elucidate the functional role and inherent chemistry of ingredients of concrete through stoichiometry, hydration reactions and application of microanalysis techniques. Furthermore, the course elaborates on the fundamental knowledge of fresh and hardened properties of concrete, through the effect on concrete composition and the relevant chemistry. The course will describe the degradation mechanism of concrete against different aggressive exposure conditions and design of durable concrete. Additionally, this course will demonstrate techniques of Non-Destructive Evaluations (NDE) of concrete structures. Moreover, it will describe utilization of waste materials as novel materials for use in concrete and subsequently, the outlines for designing a concrete mix which fulfills the required properties for fresh and hardened Portland cement concrete.

2**. Text Books**:

T1. Mehta, P. K., and Monteiro, P. J. M., “Concrete: Microstructure, Properties, and Materials”, 4th Ed., 2013, McGraw-Hill Education, USA.

T2. Neville, A.M, “Properties of Concrete”, 4th Edition 1996, Addison Wesley Longman Limited, Harlow, UK.

3**. Reference Books:**

R1: Taylor, H. F. W., “Cement Chemistry”, 2nd Ed., 1997, Thomas Telford Publishing, London, UK.

R2: Mindess, S., Young, J. F., and Darwin, D., “Concrete”, Second Ed., 2002, Pearson Edu, New Jersey, USA.

R3: Malhotra, V. M., and Carino, N. J., “Handbook on Nondestructive Testing of Concrete”, Second Ed., 2004, CRC Press, ASTM International, PA, USA.

R4: ASTM Standards, ACI Codes, IS Codes as necessary, and as referred in TB and RB (1 – 4).

R5: Kett, I., “Engineered Concrete: Mix Design and Test Methods”, 2nd Ed. 2010, CRC Press, T & F, FL, USA.

R6: Newman, J. and Choo, B.S., “Advanced Concrete Technology”, Vol. 1 - 4, 2003, Butterworth – Heinemann (ELSEVIER), MA, USA.

R7. Ramachandran and Beaudoin. Handbook of analytical techniques in concrete science and technology. 2002.

4. Course Plan:

Module No.	Lecture Session	Reference	Learning outcomes
1	Introduction: constituents; Cement: raw materials, manufacturing process; Composition and types, hydration, C-S-H models; Tests of cement, paste and mortar; microstructure of cementitious paste; heat of hydration; calorimetry; tests on cement, paste and mortar; microstructure of cementitious paste.	Ch 1 – 4 (T 1), Ch 6 (T 1), Ch 1, 3, 4, 5, 7 (R 1); Ch 1 – 4 (R 2)	Student will be able to analyze components of Concrete – Chemical properties of cement and cementitious paste.
2	Coarse and fine aggregates, Properties and tests on aggregates, grading of aggregates and its effect on concrete properties	Ch 7 (T 1)	Student will be able to explain aggregates and utilize them appropriately.
3	Supplementary cementitious materials (SCM): fly ash, slag, silica fume, metakaolin, rice husk ash; difference between pozzolanic and hydraulic SCM; Influence of SCMs on fresh and hardened properties of blended concrete.	Ch 5 (T 1), Ch 9 (R 1)	Student will be able to explain the chemistry of mineral admixtures and decide or justify their utility in different situations.
4	Types of chemical admixtures- Super plasticizers; VMA; Set controlling chemicals, Air entraining admixtures; Shrinkage reducing admixtures; Corrosion inhibitors. chemical compositions of admixtures; Mechanism of chemical admixtures; effect of chemical admixtures on concrete characteristics	Ch 8 (T 1)	Student will be able to develop clear understanding of the chemistry and mechanism of chemical admixtures.

5	X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy, scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), nuclear magnetic resonance (NMR), Differential scanning calorimetry (DSC), Thermogravimetric analysis (TGA). Non-Destructive Techniques for concrete evaluation.	R7- Ch 1-8	Student will be able to compare and categorize various material characterization techniques and design ways and means for characterization of a given material.
6	Effect of concrete composition on properties of fresh concrete; effect of concrete composition and curing on workability, setting times, segregation, and bleeding of fresh concrete. rheology of concrete	Ch 9, 11, 12 (T 1)	Student will be able to explain the effect of concrete composition on concrete fresh properties and design a concrete mix.
7	Effect of concrete composition on properties of hardened concrete; shrinkage and creep; correlation between micro- and specimen level properties, interfacial transition zone.	Ch 13, 14, 16 (TB 1)	Student will be able to explain the effect of concrete composition on hardened concrete properties.
8	Alkali silica reaction, freeze-thaw effect, salt attack, acid attack, sulfate attack, corrosion of embedded steel rebar, carbonation of concrete, durability tests; Prediction of concrete service life	R6- Ch 8	Student will be able to examine various durability issues of concrete and recommend preventive measures.
9	Special concretes: Light weight concrete, FRC, HPC, SCC, Geopolymer concrete, etc.	R6- Ch 2	Student will be able to categorize and design special concretes

5. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of component (Close Book/ Open Book)
Mid-Semester Test	90 min	25	<TEST_1>	Closed book
Term paper, assignments, presentation, etc.	-	40	To be announced	Open book
Comprehensive Examination	120 min	35	<TEST_C>	Closed book

6. Chamber Consultation Hour: To be announced in class

7. Notices: Notices or announcements concerning the course will be communicated via emails or Nalanda.

8. Make-up Policy: Take prior permission from I/C. Make-up will be granted with prior permission, on a case to case basis, only on genuine extraordinary reasons. For medical cases, a certificate from the concerned doctor of the Medical Centre must be produced.

Instructor-in-charge
Course No. CE G562