

**Department Mining, Petroleum, and Metallurgical Engineering**

**Cairo University
Faculty of Engineering**

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| **Course Specifications** |
| **Program(s) on which this course is given:** | Metallurgical Engineering |
| **Department offering the program:** | Mining, Petroleum and Metallurgical Engineering |
| **Department offering the course:** | Mining, Petroleum and Metallurgical Engineering |
| **Academic Level:** | 3rd Year  |
| **Date**  | 2014 |
| **Semester (based on final exam timing)** |  Fall Spring |
| **A- Basic Information** |
| **1. Title:** | Destructive and non – Destructive Testing | **Code:** | MET 304 |
| **2. Units/Credit hours per week:**  | Lectures | 4 | Tutorial | 1 | Practical | 1 | Total | 6 |
| **B- Professional Information** |
| **1. Course description:** | 1. Learn all destructive and non destructive tests namely :1- mechanical : tension , hardness , impact ,fatigue ,creep and fracture toughness tests 2- non- destructive : radiographic , magnetic , ultrasonic and dye- penetrant tests.
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|  | 1. Analyze mathematically and understand the data obtained from all tests. Also understand the various relationships between the relevant obtained data from each test , using the knowledge gained from the course of Mechanical Properties of Material.
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|  | 1. Conduct simple material design calculations for engineering parts under different loading conditions based on the data obtained from the tests and using the stress equations to learn from the course of Theory of Elasticity and Plasticity.
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| **2. Intended Learning Outcomes of Course (ILOs):** | **a) Knowledge and Understanding**1. Stress analysis in engineering applications and mechanical properties and their relationship to shaping and manufacturing methods and failure of systems. |
| **b) Intellectual Skills** |
| 2. Assess and evaluate the characteristics, performance and failure of components, systems and processes. |
| **c) Professional and Practical Skills** |
| 3. Apply knowledge of mathematics, science, information technology, design, business context and engineering practice integrally to solve metallurgical engineering problems. |
| 4. Professionally merge the engineering knowledge, understanding, and feedback to improve design, products and/or services. |
| 5. Use appropriate mechanical testing, corrosion testing, optical, X-ray, and electron metallographic, and chemical analysis methods for metals and alloys. |
| **d) General and Transferable Skills** |
| 6. Search for information and engage in life-long self learning discipline to learn ccurrent engineering technologies and contemporary metallurgical engineering topics related to metallurgical engineering. |
| **3. Contents** |
| **Topic** | **Total hours** | **Lectures hours** | **Tutorial/ Practical hours** |
| DT: Introduction: what are mechanical destructive tests and why are they carried out. Tension test: Test description, data obtained, engineering stress-strain curve, important points on the curve. NDT: Introduction: what are non-destructive tests and why are they carried out: MT, PT, UT, RT, VT. | 6 | 4 | 2 |
| DT: True stress-strain curve, some important relations between engineering and true data on the curve, deriving mathematical expressions for strain, reduction in area relationships, application of volume constancy relationship. NDT: Ultrasonic testing UT: piezoelectric effect, wave modes, velocity, relationship between velocity and elastic constants. reflection, refraction, mode conversion.  | 6 | 4 | 2 |
| DT: Tension test: Instability criteria, effect of strain rate and temperature on tensile properties, discussing effect of some metallurgical parameters on tensile properties f materials. NDT: UT: Snell's law, first and second critical angles, type of transducers, attenuatin, near zone, far zone, beam angle, standard blocks, main controls in the ultrasonic flow detector.  | 6 | 4 | 2 |
| DT: Hardness test: Vickers, Brinell, Rockwell. Meyer Hardness.NDT: UT: Effect of damping, frequency and crystal size on sensitivity, resolution and beam profile. Contact immersion techniques.  | 6 | 4 | 2 |
| DT: Hardness test: Micro hardness tests, relationships between hardness and tensile properties. Torsion test: test description, torque twist diagram, important data obtained from the curve. Bending test.NDT: UT: Distance and sensitivity calibration. Evaluation of defects by UT. | 6 | 4 | 2 |
| Mid-Term1 Exam on tension test. | 2 | 2 |  |
| DT: Fatigue test: Stress cycle, important parameters describing dynamic loading , fatigue test, data obtained, S-N curve, Goodman diagram, Soderberg diagram, effect of mean stress on fatigue.NDT: RT: Basic properties if ionizing radiation, radiation measuring units, x-ray sources, gamma rays sources. | 6 | 4 | 2 |
| DT: Fatigue test: Effect of stress concentration on fatigue, effect of surface condition on fatigue, effect of size on fatigue .Discussion of essay prepared by students on Metallurgical measures taken to improve fatigue (surface hardening, shot peening).NDT: RT:X-ray sources, gamma rays sources, image on films, filters, film development. | 6 | 4 | 2 |
| DT: Fatigue test: Cyclic stress; low and high cyclic fatigue, strain life equation, fatigue crack propagation test. Infinite life design approach and other design approaches. NDT: RT: Source film distance, choice of kilo-volt, image quality indicators.  | 6 | 4 | 2 |
| Mid-Term 2 Exam on fatigue.  | 2 | 2 |  |
| DT: Impact Toughness test: Brittle fracture, test description, specimens, transition temperature. Fracture toughness test: Fracture of metals, review of theories, stress intensity factor.NDT: RT: Calculation of exposure parameters for plates and pipes. | 6 | 4 | 2 |
| DT: Fracture toughness test: Plain strain toughness test, specimens, curves obtained, interpretation of data. K1c, fracture toughness and design. NDT: Magnetic test MT: AC and Dc currents. Evaluation of defects. | 6 | 4 | 2 |
| DT: Creep test: test, creep curve, stress rupture test, interpretation of engineering creep data, prediction of long time properties. NDT: Penetrant test PT: visible and fluorescent. | 6 | 4 | 2 |
| DT: Discussing students year work, essays and oral exam. NDT: Discussing students year work, essays and oral exam.  | 6 | 4 | 2 |
| **4. Teaching and Learning Methods** | Lectures (🗸)  | Practical Training/ Laboratory ( )  | Seminar/Workshop ( )  |
| Class Activity (🗸)  | Case Study ( )  | Projects (🗸)  |
| E-learning ( )  | Assignments /Homework (🗸)  | Other:  |
| **5. Student Assessment Methods** |
| * **.Assessment Schedule**
 | **Week** |
| -Assessment 1; Class test  | 4 |
| -Assessment 2; Project Assignment  |  |
| -Assessment 3; Presentations  |  |
| -Assessment 3; Midterm Exam | 8 |
| -Assessment 4; Final Exam | End of term |
| * **Weighting of Assessments**
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| -Mid-Term Examination | 15 % |
| -Final-term Examination  | 70 % |
| -Project |  |
| -Class Test | 5 % |
| -Presentation |  |
| -Total | 100 % |
| **6. List of References** |
| 6.a. Course Notes |
| 6.b. Essential Books (Text Books) |
| * Suggested by the Academic Advisor
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| 1. Mechanical Metallurgy; G. E. Dieter, Mc. Graw-Hill Book Company, 1988. (Part 4, ch15-20).
 |
| 1. Engineering metallurgy; R. Higgins, part 2: Metallurgical Process Technology, ELBS, 1974. Ch.8,9,10,11.
 |
| 1. Mechanical Working of Metals: Theory and Practice; Pergamon International Library.
 |
| 4. The Rolling of Strip, Sheet, and Plate; E. C. Larke, Chapmann and Hall Ltd., 1963 |
| 6.c. Recommended Books. |
| * Suggested by the Academic Advisor
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| 6.d. Periodicals, Web Sites, … etc: N/A |
| **7. Facilities Required for Teaching and Learning** |
| - Small group of students.  |
| - Up-to-date references in library. |
| **Course Coordinator:** | Prof. Dr. Nahed A. Abdel Raheem |
| **Head of Department:**  | Prof. Dr. E.M. Elbanna |

