University of Chemical Technology and Metallurgy – Sofia
Centre of Materials Science

Approved:……
Director (Dean):……..

S Y L L A B U S

Course: "Environmental Failure and Protection of Materials"
Subject: "Materials Science and Engineering"
Degree: M.S.

Prepared by:
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/Prof. Dr. R. Raicheff/
…….
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Department: "Inorganic and Electrochemical Productions"

Head of the Department:……
/Assoc. Prof. Dr. L.Fachikov/

Sofia, 2006

SYLLABUS

of the course: “Environmental Failure and Protection of Materials”

I. CURRICULUM

Type of classes	Semester	Hours/Form
1. Lectures	II	20
2. Laboratory classes	II	20
3. Control	II	Exam
4. Credits	II	4

II. SYNOPSIS

The compulsory course “Environmental Failure and Protection of Materials” is designed for M.S. students in “Materials Science and Engineering”. The aim of the course is to improve both the fundamental and general engineering knowledge of the students for the Materials. The lecture course builds up knowledge of the contemporary concepts for corrosion processes of metallic materials and environmental degradation of ceramic and polymer materials. In the laboratory classes the students are acquainted with experimental methods and apparatuses for study of corrosion processes and environmental failure of materials as well as with the basic methods for protection of materials.

Prerequirements: Physics, General Chemistry, Material Science, Physical Chemistry.

III. LECTURE COURSE

1. Electrochemical mechanisms of corrosion of metals -1h

Electrode potential. Nernst equation. Oxy-reduction potentials. General characteristics of electrochemical corrosion.

2. Corrosion cells -3h.

Electrochemical heterogeneity of metallic materials. Models of corrosion cell. Corrosion thermodynamics – Pourbaix diagrams. Polarization of the corrosion cell. Activation controlled kinetics and concentration polarization. Evans diagrams.

3. Partial corrosion reactions -2h.
Anodic dissolution of metals. Cathodic reactions – oxygen reduction and hydrogen evolution. Basic kinetics. Mixed potential theory in corrosion kinetics.

4. Corrosion of materials in natural environments -2h.
Atmospheric corrosion – general characteristics, mechanism and prevention. Soil corrosion – general characteristics, mechanism and prevention.

5. Localized corrosion damages and materials failure -2h.
Passivity and transpassivity of metals. Breakdown of passivity and pitting corrosion. Stress – corrosion cracking of materials. Intergranular corrosion failure.

6. Corrosion failure of ceramic materials -2h.
Mechanisms of corrosion ceramics. Effect of chemical and phase composition and structure on corrosion resistance. Corrosion degradation of concrete.

7. Environmental degradation and corrosion of polymer materials -2h.
Destruction of polymers – types and mechanism. Effect of composition and structure on environmental degradation of polymer materials.

8. Methods for protection of materials -5h.
Overview of corrosion prevention methods. Chemical and electrochemical surface treatment of metals. Metallic, inorganic and organic protective coatings. Application of inhibitors. Electrochemical methods for corrosion protection.

9. Corrosion control and monitoring -1h.
Principles of material selection. Corrosion testing and monitoring.

IV. LABORATORY CLASSES

1. Model of corrosion cell with oxygen reduction.
2. DC polarization measurements of corrosion rate in electrolytic environment using computerized electrochemical apparatus.
3. Potential sweep technique for study of passivity of metals.
4. Stress – corrosion cracking of metals.
5. Study of pitting corrosion by electrochemical polarization methods.
6. Chemical resistance of concretes.

7. Corrosion of polymer materials.
8. Conversion phosphate coatings on steel.
9. Electrodeposition of zinc coatings.
10. Material selection using data base and Internet information sources.

V. LITERATURE

1. M. G. Fontana “Corrosion Engineering”, Mc Graw Hill, New York, 1997
2.”Corrosion Metal Environment Reactions” eds. L L. Shreir, R. A. Jerman, G. T. Burstein, Butterwirths, London, 1994
3. D. Gabe “Principles of Metal Surface Treatment and Protection”, Merlin Books, London, 1993
4. R. Raicheff “Corrosion and Protection of Materials”, New Sciences, Sofia, 2001 (in Bulgarian)
5. R. Raicheff, L. Fachikov, V. Zaprianova “Corrosion and Protection of Materials – Manuel for Laboratory”, UCTM, Sofia, 2002 (in Bulgarian).

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