



## COURSE DATASHEET

|                                |   |
|--------------------------------|---|
| <b>Semester:</b>               | 2012/13/2                                     |
| <b>Course:</b>                 | Industrial catalysis                          |
| <b>Code:</b>                   | VEMKTEV214K                                   |
| <b>Responsible department:</b> | Department of Hydrocarbon and Coal Processing |
| <b>Department code:</b>        | MKOL  |
| <b>Responsible instructor:</b> | Dr. Jenő Hancsók                              |

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### Course objectives:

Combination of theoretical and practical chemical engineering knowledge on the area of catalysis.

### Course content:

1. The place and role of the industrial catalysis in the hydrocarbon processing industry. Historical review of industrial catalysis. Classification of catalytic processes. Homogeneous and heterogeneous catalysis. Enzymatic catalysis.
2. Requirements of catalysts, properties for applicability: activity, selectivity, stability, morphological properties, mechanical stability, shape and size, thermal stability, period of activity, lifetime, reproducible production, cost.
3. Classification, design and selection of catalysts. Ideal and optimal catalysts.
4. Catalysts for homogeneous application.
5. Heterogeneous catalysts I.
6. Heterogeneous catalysts II., role of metal components and promoters.
7. Shape selective catalysts.
8. Examples for catalysts production.
9. Basic knowledge of kinetics.
10. Survey of catalytic systems and reactor systems. Aspects of selection of reactors and reactor arrangements.
11. Operation of catalytic reactors: checking process before catalyst loading, start-up of different type of catalysts (drying, pre-treatment etc.), continuous checking of process parameters, catalyst sample taking during the operation etc.
12. Regeneration of catalyst ("in situ" and "ex situ").
13. Preparation of catalysts for metal content recovery, unloading of reactors, hazards, safety procedures.
14. Recovery and recycling of metal components of catalysts.
15. Catalytic processes of the hydrocarbon industry and the environmental protection.

### Requirements, evaluation and grading:

The method of scoring is written examination. Minimum requirement is 50%. For the score of 5 higher than 85% is required.



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### Required and recommended readings:

Kötelező és ajánlott irodalom: M. Boudart, G. Djega-Mariadasson: Kinetics of Heterogeneous Catalytic Reactions. Princeton Univ. Press, Princeton, 1984. Bond, G. C.: Heterogén katalízis, elvek és alkalmazások, Műszaki Könyvkiadó, 1990. G. Ertl, H. Knözinger, J. Weitkamp: Handbook of Heterogeneous Catalysis vol. 1-4. Wiley-Vch 1997 Faigl F., Kollár L., Kotschy A., Szepes L.: Szerves Fémvegyületek Kémiaja, Nemzeti Tankönyvkiadó, Budapest, 2001. K. Weissermel, H.- J. Arpe: Industrial Organic Chemistry, Fourth, Revised Edition, Wiley-VCH, Weinheim, 2003. (magyar ford.: Ipari Szerves Kémia, Nemzeti Tankönyvkiadó, Bp, 1993.) Ch. Elschenbroich, A. Salzer: Organometallics, Weinheim, VCH Verlag GmbH, 1992. H. Bahrmann, H. Bach: Oxo Synthesis in Ullmann's Encyclopaedia of Industrial Chemistry, Wiley-VCH Verlag GmbH, 2000. I. T. Horváth (ed): Encyclopedia of Catalysis Vol. 1-6; New Jersey; Wiley-Interscience, 2003. W. Tang, X. Zhang: New chiral phosphorus ligands for enantioselective hydrogenation, Chem. Rev., 103, 3029-3069, 2003. Leach, B.E.: Applied Industrial Catalysis, Vol. 1-3. Academic Press, New York, 1983. Le Page, J.-F. et al.: Applied Heterogeneous Catalysis. Éditions Technip. Paris, 1987. Meyers, R.A.: Handbook of Petroleum Refining Process, McGraw-Hill Book Company, New York, ..., Toronto, 1986. Trimm, D.I. et al.: Catalysis in Petroleum Refining, 1989 Elsevier, Amsterdam, Tokyo, 1990. Jones, T.C.: Diesel Plant Operations Handbook, McGraw-Hill Inc., N.Y., 1991. Delannay, F.: Characterization of Heterogeneous Catalysts, Marcel Dekker, N.Y., 1984. Szostak, R.: Molecular Sieves, Van Nostrand Reinhold, N.Y., 1989. Moffat, J.B.: Theoretical Aspects of heterogeneous Catalysis, Van Nostrand Reinhold, N.Y., 1990. Chen, N.Y. et al.: Shape Selective Catalysis in Industrial Applications 2.edition, Marcel Dekker Inc., N.Y. Basel Hong Kong, 1996. Satterfield, C.N.: Heterogeneous Catalysis in Industrial Practice, McGraw-Hill Inc., N.Y., 1991. Rase, H.F.: Fixed Bed Reactor Design and Diagnostics, Butterworths, Boston, 1990. Stiles, A.B. és Koch, T.A.: Catalyst manufacture 2. kiadás, Marcel Dekker Inc., N.Y. Basel Hong Kong, 1995. Masel, R.I.: Chemical kinetics and catalysis, John Wiley and Sons, Inc., 2001. Becker, E.R. és Pereira, C.J.: Computer-aided design of catalysts, Marcel Dekker Inc., N.Y. Basel Hong Kong, 1993. A. F. Carley, P. R. Davies, G. J. Hutchings, M. S. Spencer: Surface Chemistry and Catalysis, 2002, 381 oldal B. Viswanathan S. Sivasanker, A. V. Ramaswamy: Catalysis Principles and Applications, 2002, 412 oldal, ISBN: 81-7319-375-4. Becker, E.R., Pereira, C.J.: „Computer-Aided Design of Catalysts”, Marcel Dekker Inc., 1993, 620 oldal (2 kötet) Chunshan Song, Juan M. Garcés and Yoshihiro Sugi: „Shape - Selective Catalysis”, 2001, 408 oldal (2 kötet) Fogler, H.S.: „Elements of Chemical Reaction Engineering”, Prentice Hall International, 1992, 838 oldal Gates, B.C., Katzer, J.R., Schuit, G.C.A.: „Chemistry of Catalytic Processes”, McGraw-Hill, 1979, 387 oldal Imelik, B., Vedrine, J.C.: „Catalyst Characterization – Physical techniques for Solid Materials”, Plenum Press, 702 oldal (5 kötet) Michiels, P., De Herdt, O.C.E.: „Molecular Sieve Catalysts”, Pergamon Press, 1987, 381 oldal Oláh, Gy., Molnár, Á.: „Hydrocarbon Chemistry”, John Wiley & Sons Inc., 1995, 632 oldal (3 kötet) Serge Raseev: „Thermal and Catalytic Processes in Petroleum Refining”, 2003, 920 oldal (2 kötet) Somorjai, G.A.: „Introduction to Surface Chemistry and Catalysis”, John Wiley & Sons Inc., 1994, 617 oldal (4 kötet) Stiles, A.B., Koch, T.A.: „Catalyst Manufacture”, Marcel Dekker Inc., 1995, 288 oldal Weitkamp, J.: „Catalysis and Zeolites”, Springer,



# UNIVERSITY OF PANNONIA

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### Required and recommended readings:

1999 Berty, J.M.: "Experiments in Catalytic Reaction Engineering", Elsevier, 1999, Amsterdam,.....,Tokyo, ISBN: 0 444 82823 0. (VZ) Auerbach, S.M.; Carrado, K.A, Dutta, P.K.: „Handbook of Zeolite Science and Technology“, Marcel Dekker Inc., 2003, New York, Basel