# NEEP -423
# Nuclear Engineering Materials
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**Office Hours 2:25-4:00 PM Monday**

## NEEP 423 Grading Procedure

- **Exams - 80 %**
  - **2 one hour exams @ 25 % ea**
  - **Final Exam - 30 %**
- **Problems - 10 %**
  - **Periodic assignments**
  - **Possible Writing Assignment**
- **Class Participation -10 %**
  - **Attendance**
  - **Interest**
  - **Questions**

| | | | | |
|---|---|---|---|---|
| 2-Sep-99 | | | | |
| ***Syllabus For NEEP 423-Fall 1999*** | | | | |
| | | | **Nuclear Engineering Materials*** | |
| | | | Room 235 Materials Science | |
| | | | 11:00-11:50 AM, MWF | |
| **Date** | **#** | **Day** | **Topic** | **Reference** |
| 3-Sep | 1 | F | Introduction | notes |
| 9-Sep | 2 | R | Materials for Fission Reactors | notes |
| 10-Sep | 3 | F | Metallic Fuels | notes/Ref Book |
| 13-Sep | 4 | M | Metallic Fuels | notes/Ref Book |
| 15-Sep | | W | No Class | |
| 17-Sep | 5 | F | LMR Fuels | notes/Ref Book |
| 20-Sep | 6 | M | LMR Fuels | notes/Ref Book |
| 22-Sep | 7 | W | Enrichment of Nuclear Fuels | Notes |
| 24-Sep | 8 | F | Enrichment of Nuclear Fuels | Notes |
| 27-Sep | 9 | M | Zircalloy | notes/Ref Book |
| 29-Sep | 10 | W | Zircalloy | notes/Ref Book |
| 1-Oct | 11 | F | Failure of Fuel Elements | Garzarolli Article |
| 4-Oct | 12 | M | Exam | |
| 6-Oct | 13 | W | Failure of Fuel Elements | Garzarolli Article |
| 8-Oct | 14 | F | Chapter 10 Fuel Element Performance | Olander |
| 11-Oct | 15 | M | Chapter 10 Fuel Element Performance | Olander |
| 13-Oct | 16 | W | Chapter 10 Fuel Element Performance | Olander |
| 15-Oct | 17 | F | Chapter 10 Fuel Element Performance | Olander |
| 18-Oct | 18 | M | Chapter 11 Fuel Element Chemistry | Olander |
| 20-Oct | | W | No Class | |
| 22-Oct | 19 | F | Chapter 11 Fuel Element Chemistry | Olander |
| 25-Oct | | M | No Class | |
| 27-Oct | 20 | W | Chapter 11 Fuel Element Chemistry | Olander |
| 28-Oct | 21 | R | Chapter 11 Fuel Element Chemistry | Olander |
| 1-Nov | | M | No Class | |
| 3-Nov | | W | No Class | |
| 5-Nov | | F | No Class | |
| 8-Nov | 22 | M | Chapter 12 Behaviour of Fission Products | Olander |
| 10-Nov | 23 | W | Chapter 12 Behaviour of Fission Products | Olander |
| 11-Nov | 24 | R | Chapter 13 Swelling Due to Fission Products | Olander |
| 12-Nov | 25 | F | Chapter 13 Swelling Due to Fission Products | Olander |
| 15-Nov | 26 | M | Chapter 13 Swelling Due to Fission Products | Olander |
| 17-Nov | 27 | W | Chapter 13 Swelling Due to Fission Products | Olander |
| 19-Nov | 28 | F | Chapter 13 Swelling Due to Fission Products | Olander |
| 22-Nov | 29 | M | Exam | |
| 23-Nov | 30 | Tu | Chapter 14 Pore Migration and Restructuring | Olander |
| 24-Nov | 31 | W | Chapter 14 Pore Migration and Restructuring | Olander |
| 26-Nov | | | Thanksgiving Break | |
| 29-Nov | 32 | M | Chapter 15-Fission Gas Release | Olander |
| 1-Dec | 33 | W | Chapter 15-Fission Gas Release/Corrosion | Olander/notes |
| 3-Dec | 34 | F | Embrittlement of Pressure Vessels | Shah Article |
| 6-Dec | 35 | M | Embrittlement of Pressure Vessels | Shah Article |
| 8-Dec | 36 | W | Fusion Fuels/Materials General | notes |
| 10-Dec | 37 | F | Fusion Materials-Tritium | notes |
| 12-Dec | 38 | M | Fusion Materials-Structural | notes |
| 15-Dec | 39 | W | Fusion Materials-Radioactive Waste | notes |
| 20-Dec | | | Final Exam-12:25/12/20 | |
| | | | | |
| * Web Site | http://silver.neep.wisc.edu/~neep423/FALL99/neep423.html | | | |

# Reference List for Course NEEP-423


1. Wilkinson, W.D. and Murphy, W.F., "Nuclear Reactor Metallurgy," Van Nostrand Co., New York, NY, 1958.

2. Garzaolli, F., R. von Jan, and H. Stehle, "The Main Causes of Fuel Failure in Water Cooled Power Reactors", Atomic Energy Review, Vol. 17, No. 1, p. 31 (1979)

3. Wymer, Raymond G. and Vondra, Benedict L., "Light Water Reactor Nuclear Fuel Cycle," CRC Press, Inc., Boca Raton, FL, 1981.

4. Roberts, J.T. Adrian, "Structural Materials in Nuclear Power Systems," Plenum Press, New York, NY, 1981.

5. Frost, Brian R.T., "Nuclear Fuel Elements," Pergamon Press, Elmsford, NY, 1982.

6. Ma, Benjamin M., "Nuclear Reactor Materials and Applications," Van Nostrand Reinhold Company, New York, NY, 1983.

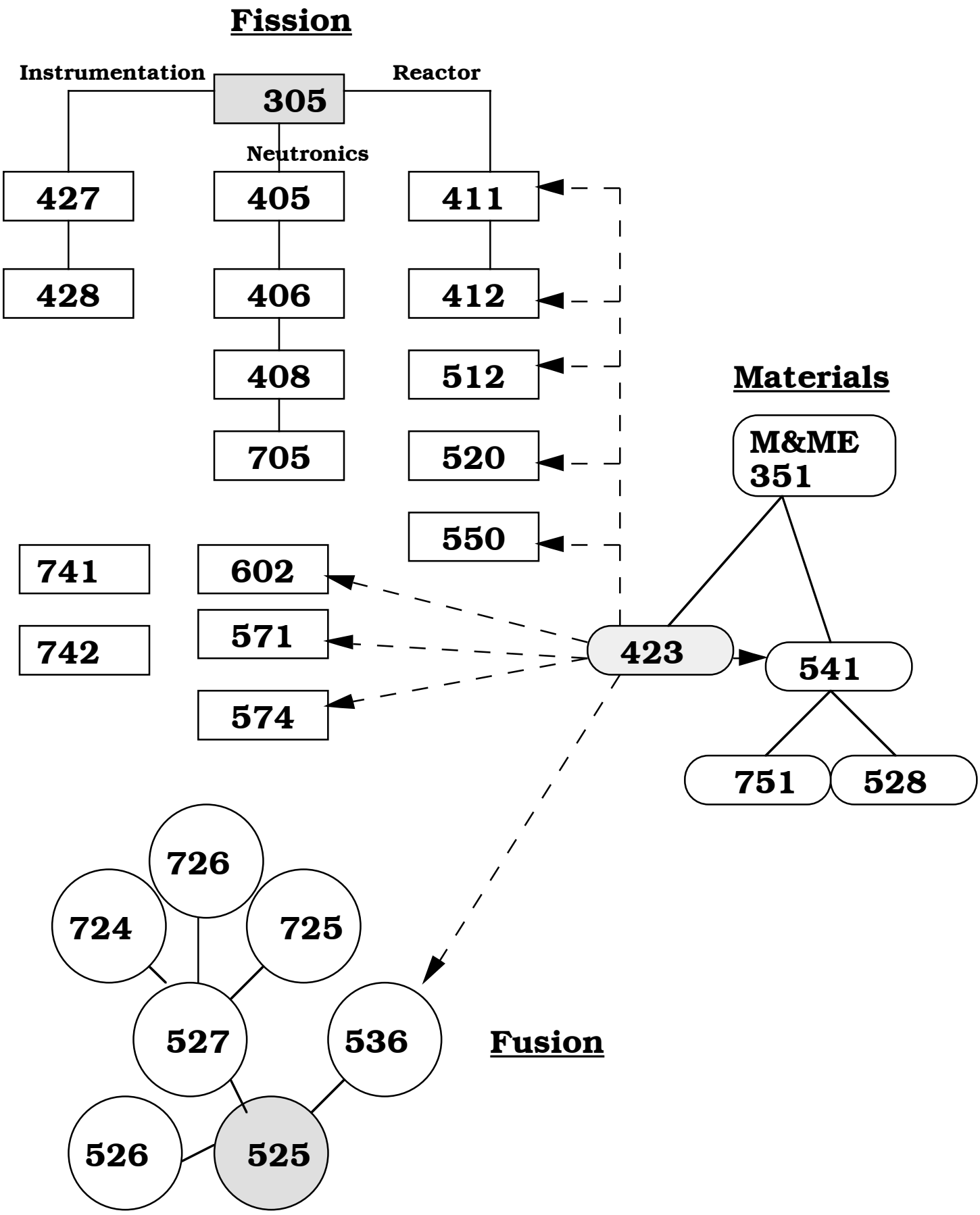
7. Olander, Donald R., "Fundamental Aspects of Nuclear Reactor Fuel Elements," TID-26711-P1, Technical Information Center, Springfield, Virginia, March 1985.

8. Shah, V. N., and P. E. MacDonald, "Aging and Life Extension of Major Light Water Reactor Components", Elsevier Publishers, Amsterdam, 1993

9. "Materials Science and Technology", Edited by R. W. Cahn, P. Haasen, E. J. Kramer, Volume 10A & 10B, VCH Publishers, New York, 1994

10. "Proceedings of the 1997 International Topical Meeting on Light Water Reactor Fuel Performance", Portland, OR, March 2-6, 1997

# Relationship of NEEP-423 to Other NEEP Courses



# Scope of Materials Problems for Nuclear Energy

| **Fission** | **Fusion** |
|---|---|
| *Fuel* | *First Wall* |
| *Cladding* | *Blanket Struc.* |
| *Core Struc.* | *Breeder* |
| *Contol Rods* | *Reflector* |
| *Reflector* | *Shield* |
| *Pressure Vessel* | *Direct Conv.* |
| | *Electrical Insul.* |
| | *S/C Magnets* |
| | *Lasers* |
| | *Optics* |
| | *Accelerators* |
| | *RF or Particle Beams* |

*Piping ---------->*
*Pumps---------->*
*Heat Exchangers---------->*
*Turbines---------->*
*Generators---------->*
*Transmission---------->*

# Materials used in the Construction of Fission Reactors

| | |
|---|---|
| **U, Pu, Th** | **Fissionable and fertile elements, generally used as an alloy, ceramic, or cermet** |
| **Al, Mg, Zr, Be, C** | **Elements with low thermal neutron capture cross sections. Could be used for cladding for thermal reactors. Carbon and Be can also be used for moderators and reflectors.** |
| **Nb, Mo, Ta, V, W** | **Refractory metals with capture cross sections suitable for fast reactors.** |
| **Na, Na-K, Li-7, Bi,Pb, Cs** | **Liquid metals for use as heat transfer media. Bi has also been considered as a solvent for U in a LMR** |
| **Construct. Steels (Fe, Ni, Cr, Mn)** | **Range from mild steels for pressure vessels to fully austenitic or ferritic steels for core structure.** |
| **B, Hf, Cd, Ag, Gd** | **Elements with extremely high absorption cross sections for control rods.** |
| **Organic coolants** | **Used where high temperature is required without high pressure** |