

**IMPORTANT:** This syllabus form should be submitted to OAA ([gsbs\\_academic\\_affairs@uth.tmc.edu](mailto:gsbs_academic_affairs@uth.tmc.edu)) a week before the start of each semester.

**NOTE to STUDENTS:** If you need any accommodations related to attending/enrolling in this course, please contact one of the Graduate School's 504 Coordinators, Cheryl Spitzenberger or Natalie Sirisaengtaksin. We ask that you notify GSBS in advance (preferably at least 3 days before the start of the semester) so we can make appropriate arrangements.

<p>Term and Year: <b>Fall 2023</b></p> <p>Course Number and Course Title: <b>GS02 1193 Introduction to Medical Physics IV: The Physics of Nuclear Medicine</b></p> <p>Credit Hours: <b>3</b></p> <p>Meeting Location: <b>MD Anderson Main Main Bldg.</b></p> <p>Building/Room#: <b>CPB5.3312</b></p> <p>WebEx/Zoom Link: <b>N/A</b></p>	<p>Program Required Course: <b>Yes</b></p> <p>Approval Code: <b>Yes</b> <b>(If yes, the Course Director or the Course Designee will provide the approval code.)</b></p> <p>Audit Permitted: <b>Yes</b></p> <p>Classes Begin: <b>August 28, 2023</b></p> <p>Classes End: <b>December 8, 2023</b></p> <p>Final Exam Week: <b>December 11-15, 2023</b></p>
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**Class Meeting Schedule**

Day	Time
<b>Monday/Wednesdays</b>	<b>2:30-4:00</b>

<p><b>Course Director:</b></p> <p>Name and Degree: <b>Rachel Barbee, PhD</b></p> <p>Title: <b>Associate Professor</b></p> <p>Department: <b>Imaging Physics</b></p> <p>Institution: <b>MDACC</b></p> <p>Email Address: <a href="mailto:rbarbee@mdanderson.org">rbarbee@mdanderson.org</a></p> <p>Contact Number: <b>(713) 563-4712</b></p> <p><b>Course Co-Director/s:</b> (if any)</p> <p>Name and Degree: <b>Richard Wendt, PhD</b></p> <p>Title: <b>Professor</b></p> <p>Department: <b>Imaging Physics</b></p> <p>Institution: <b>MDACC</b></p>	<p><b>Instructors:</b></p> <ol style="list-style-type: none"> <li>1. <b>Rachel Barbee, PhD</b> Institution: MD Anderson Email Address: <a href="mailto:rbarbee@mdanderson.org">rbarbee@mdanderson.org</a></li> <li>2. <b>Richard Wendt, PhD</b> Institution: MD Anderson Email Address: <a href="mailto:rwendt@mdanderson.org">rwendt@mdanderson.org</a></li> <li>3. <b>William Erwin, MS</b> Institution: MD Anderson Email Address: <a href="mailto:werwin@mdanderson.org">werwin@mdanderson.org</a></li> <li>4. <b>Osama Mawlawi, PhD</b> Institution: MD Anderson Email Address: <a href="mailto:OMawlawi@mdanderson.org">OMawlawi@mdanderson.org</a></li> </ol>
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<p>Email Address: <a href="mailto:rwendt@mdanderson.org">rwendt@mdanderson.org</a></p> <p>Contact Number: <b>(713) 745 3250</b></p> <p><b>NOTE:</b> Office hours are available by request. Please email me to arrange a time to meet.</p> <p><b>Teaching Assistant:</b> (if any)</p> <p><b>N/A</b></p> <p>Name and Email Address</p>	<p><b>4. Tinsu Pan, PhD</b></p> <p>Institution: MD Anderson</p> <p>Email Address: <a href="mailto:TPan@mdanderson.org">TPan@mdanderson.org</a></p> <p><b>5. Jim Simon, PhD</b></p> <p>Institution: Iso Therapeutics</p> <p>Email Address: <a href="mailto:jimsimon@isotherapeutics.com">jimsimon@isotherapeutics.com</a></p> <p><b>6. Charles H. Manning, PhD</b></p> <p>Institution: MD Anderson</p> <p>Email Address: <a href="mailto:HCManning@mdanderson.org">HCManning@mdanderson.org</a></p> <p><b>7. Raymond Pahlka, PhD</b></p> <p>Institution: Texas Childrens Hospital</p> <p>Email Address: <a href="mailto:rbpahlka@texaschildrens.org">rbpahlka@texaschildrens.org</a></p> <p><b>8. Carly Hansen, MS</b></p> <p>Institution: Texas Children’s Hospital</p> <p>Email Address: <a href="mailto:cmhansen@texaschildrens.org">cmhansen@texaschildrens.org</a></p>
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**Course Description:**

This course teaches the principles of medical physics that apply to nuclear medicine in both its diagnostic and therapeutic aspects. The fundamentals of atomic and nuclear physics, radioactive decay, and radiation detection are applied to the instrumentation that is used in nuclear medicine for quality control, non-imaging physiological measurements, and the imaging of single photon emissions and positron emissions using planar and tomographic acquisition means including X-ray computed tomography for attenuation correction and anatomical correlation. Radiopharmaceutical chemistry is introduced. Radiation internal dosimetry is developed and applied to therapeutic treatment planning.

**Textbook/Supplemental Reading Materials (if any)**

Simon R. Cherry, James A. Sorenson and Michael E. Phelps, *Physics in Nuclear Medicine: Fourth Edition*, Philadelphia: W.B. Saunders, 2012, ISBN 978-1-4160-5198-5

Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt, Jr., and John M. Boone, *The Essential Physics of Medical Imaging*, 3rd Ed., Philadelphia: Wolters Kluwer | Lippincott, Williams & Wilkins, 2011, ISBN 978-0781780575

SNMMI MIRD Committee, *MIRD Primer 2022: A complete guide to radiopharmaceutical dosimetry*, Society of Nuclear Medicine and Molecular Imaging. 2022 ISBN 9780932004031

**Supplemental**

Fred Mettler and Milton Guiberteau, *Essentials of Nuclear Medicine and Molecular Imaging*, 7<sup>th</sup> Ed., Saunders, 2018, ISBN 978-0323483193

Robert E. Henkin, et al., eds., *Nuclear Medicine*, St. Louis: Mosby, 1996, ISBN 0-8016-7701-7, Chapters 1-39 for basic science and others for clinical background.

**Course Objective/s:**

***Specific Learning Objectives:***

1. Understand the physics and operation of clinical nuclear medicine and PET equipment.
2. Understand basic principles of radionuclide production and radiopharmaceutical chemistry.
3. Understand basic dosimetry of radiopharmaceutical therapy
4. Perform basic absorbed dose estimates for patients administered radiopharmaceuticals for therapy.

**Student Responsibilities and Expectations:**

1. Participate in and contribute to course discussions during lecture and review sessions.
2. Participate in lab sessions and prepare lab reports.
3. Prepare for and take a final examination based on the lecture and some reading material.

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Students are expected to complete all assigned reading material prior to class. While you may work and discuss all course materials and assignments in groups, all writing assignments must be your own. Plagiarism and failure to properly cite scientific literature and other sources will not be tolerated and are grounds for dismissal from the course and further GSBS disciplinary action. Cheating or engaging in unethical behavior during examinations (quizzes and final) will be grounds for dismissal from the course without credit and further GSBS disciplinary action.

**Grading System: Letter Grade (A-F)**

**Student Assessment and Grading Criteria :** *(May include the following:)*

Percentage	Description
Midterm Exams ( 25 %)	
Final Exam ( 25 %)	
Lab Session + Report ( 25 %)	
Participation and/or Attendance ( 25 %)	

**CLASS SCHEDULE**

<b>Date</b>	<b>Duration (Hour(s) taught by lecturer)</b>	<b>Lecture Topic</b>	<b>Lecturer/s</b>
28 Aug	<b>1.5</b>	Course Overview & Review of Atomic and Nuclear Physics and Radioactive Decay	RB
30 Aug	<b>1.5</b>	Characteristics of Digital Images	RW
6 Sep	<b>1.5</b>	Radiation Detection and Counting Statistics	RP
11 Sep	<b>1.5</b>	Gamma Camera I	CH
13 Sep	<b>1.5</b>	Gamma Camera II	RW
18 Sep	<b>1.5</b>	Backprojection SPECT Reconstruction	WE
20 Sep	<b>1.5</b>	Iterative SPECT Reconstruction	WE
25 Sep	<b>3</b>	Gamma Camera Lab	RB, RW
27 Sep	<b>1.5</b>	Radionuclide Production and Characteristics	CM
2 Oct	<b>1.5</b>	Non-imaging Instrumentation	RB
4 Oct	<b>3</b>	Non-imaging Instrumentation Lab	WE, RB
9 Oct	<b>3</b>	SPECT Lab	WE, RB
11 Oct	<b>1.5</b>	Nuclear Medicine Quality Control	RB
16 Oct	<b>1.5</b>	NM Applications	RB
18 Oct	<b>1.5</b>	First Examination	RB, RW
23 Oct	<b>1.5</b>	Radiopharmaceutical Chemistry	JSi
25 Oct	<b>3</b>	Basic Radiolabeling Lab	JSi, RW
30 Oct	<b>1.5</b>	Positron Emission Tomography I	OM
1 Nov	<b>1.5</b>	Positron Emission Tomography II	OM
6 Nov	<b>1.5</b>	Positron Emission Tomography III	OM
8 Nov	<b>1.5</b>	Hybrid Imaging I	TP
13 Nov	<b>1.5</b>	Hybrid Imaging II	TP
15 Nov	<b>3</b>	PET and PET/CT Lab	TP, OM
20 Nov	<b>1.5</b>	Internal Dosimetry – I	RW
22 Nov	<b>1.5</b>	Internal Dosimetry - II	RW
27 Nov	<b>1.5</b>	Radionuclide Therapy Treatment Planning	WE
29 Nov	<b>3</b>	Internal Dosimetry and Therapy Lab	WE
4 Dec	<b>3</b>	Y-90 Lab	WE, RB
6 Dec	<b>1.5</b>	Second Examination	RW, RB

**NOTE:** See attached schedule.

RB/jal

**Fall 2023 GS02 1193 Introduction to Medical Physics IV**  
**The Physics of Nuclear Medicine**  
**Co-ordinator: Rachel Barbee, Ph.D., Associate Professor, UTMDACC**  
 (713)563-4712, CPB5.3315, rbarbee@mdanderson.org

**Lectures:** Mondays and Wednesdays, 2:30-4:00 p.m., Room CPB5.3312

**Labs:** The time of day and the location vary

Lecture	Lab	Date	Title	Reading	By
1		28 Aug	Course Overview & Review of Atomic and Nuclear Physics and Radioactive Decay	CSP 2, 3, 4	RB
2		30 Aug	Characteristics of Digital Images	CSP 1, F, G, 15, 19	RW
		4 Sep	Labor Day Holiday		
3		6 Sep	Radiation Detection and Counting Statistics	CSP 7, 9	BP
4		11 Sep	Gamma Camera I	CSP 13-14; BB18	CH
5		13 Sep	Gamma Camera II	CSP 13-14	RW
6		18 Sep	Backprojection SPECT Reconstruction	CSP 16; BB 10	WE
7		20 Sep	Iterative SPECT Reconstruction	CSP 16; BB 10	WE
	1	25 Sep	Gamma Camera Lab	CSP 11; BB 17	RB, RW
8		27 Sep	Radionuclide Production and Characteristics	CSP 3, 5; BB 16	CM
9		2 Oct	Non-imaging Instrumentation	CSP 12	RB
	2	4 Oct	Non-imaging Instrumentation Lab	CSP 17; BB 19	WE, RB
	3	9 Oct	SPECT Lab		WE, RB
10		11 Oct	Nuclear Medicine Quality Control	CSP 11, 14-15; BB 18-19	RB
11		16 Oct	NM Applications		RB
12		18 Oct	First Examination		RB, RW
13		23 Oct	Radiopharmaceutical Chemistry	CSP 5; BB 16	JSi
	4	25 Oct	Basic Radiolabeling Lab		JSi, RW
14		30 Oct	Positron Emission Tomography I	CSP 18; BB 19	OM
15		1 Nov	Positron Emission Tomography II	CSP 18; BB 19	OM
16		6 Nov	Positron Emission Tomography III	CSP 18; BB 19	OM
17		8 Nov	Hybrid Imaging I	CSP 19; BB 19	TP
18		13 Nov	Hybrid Imaging II	CSP 19; BB 19	TP
	5	15 Nov	PET and PET/CT Lab		TP, OM
19		20 Nov	Internal Dosimetry – I	CSP 22; BB 16	RW
20		22 Nov	Internal Dosimetry - II	CSP 22; BB 16	RW
21		27 Nov	Radionuclide Therapy Treatment Planning	AAPM 71	WE
22	6	29 Nov	Internal Dosimetry and Therapy Lab		WE
	7	4 Dec	Y-90 Lab		WE, RB
23		6 Dec	Second Examination		RW, RB

**Presenters:** RW — Richard Wendt, Ph.D. TP — Tinsu Pan, Ph.D. JSi — Jim Simon, Ph.D. CM — H. Charles Manning, Ph.D.  
 OM — Osama Mawlawi, Ph.D. WE — William Erwin, M.S. RB --- Rachel Barbee, Ph.D. BP --- Raymond B (Benton) Pahlka, Ph.D.  
 CH-Carly Hansen, M.S.

This course teaches the principles of medical physics that apply to nuclear medicine in both its diagnostic and therapeutic aspects. The fundamentals of atomic and nuclear physics, radioactive decay and radiation detection are applied to the instrumentation that is used in nuclear medicine for quality control, non-imaging physiological measurements and the imaging of single photon emissions and positron emissions using planar and tomographic acquisition means including X-ray computed tomography for attenuation correction and anatomical correlation. Radiopharmaceutical chemistry is introduced. Radiation internal dosimetry is developed and applied to therapeutic treatment planning.

## Strongly Recommended Textbooks:

- Simon R. Cherry, James A. Sorenson and Michael E. Phelps, *Physics in Nuclear Medicine: Fourth Edition*, Philadelphia: W.B. Saunders, 2012, ISBN 978-1-4160-5198-5. ~\$130 [CSP in the readings above. The fourth has been significantly updated from previous editions.]
- Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt, Jr., and John M. Boone, *The Essential Physics of Medical Imaging*, 3rd Ed., Philadelphia: Wolters Kluwer | Lippincott, Williams & Wilkins, 2011, ISBN 978-0781780575. ~\$212 [BB in the readings]
- SNMMI MIRD Committee, *MIRD Primer 2022: A complete guide to radiopharmaceutical dosimetry*, Society of Nuclear Medicine and Molecular Imaging. 2022 ISBN 9780932004031

## Other Useful Textbooks:

- Fred Mettler and Milton Guiberteau, *Essentials of Nuclear Medicine and Molecular Imaging*, 7<sup>th</sup> Ed., Saunders, 2018, ISBN 978-0323483193
- Robert E. Henkin, et al., eds., *Nuclear Medicine*, St. Louis: Mosby, 1996, ISBN 0-8016-7701-7, Chapters 1-39 for basic science and others for clinical background. \$\$\$ [A newer edition is out and we have a copy of it in the physics library on CPB5.]

## Suggested References:

- Radiation Safety Manual*, Radiation Safety Office, The University of Texas M. D. Anderson Cancer Center, 2017, <http://inside.mdanderson.org/departments/facilities/emergency-safety/files/radiation-safety-manual.pdf>.
- Walter Huda, *Review of Radiologic Physics, 4<sup>th</sup> Edition*, Philadelphia: Wolters Kluwer, 2016, ISBN 978-1-4983-2508-2, \$50.
- Daniel J. Macey, et al., *A Primer for Radioimmunotherapy and Radionuclide Therapy: AAPM Report 71*, Madison: Medical Physics Publishing, 2001, ISBN 1-888340-29-0, \$15 or [http://www.aapm.org/pubs/reports/rpt\\_71.pdf](http://www.aapm.org/pubs/reports/rpt_71.pdf) [AAPM 71 in the readings above.]
- M.C. Cantone and C. Hoeschen, Eds., *Radiation Physics for Nuclear Medicine*, Heidelberg: Springer, 2011, ISBN 978-3-642-11327-7, \$174.
- Z.H. Cho, Joie P. Jones, and Manbir Singh, *Foundations of Medical Imaging*, New York: Wiley, 1993, ISBN 0-471-54573-2.
- Kristen M. Waterstram-Rich and David Gilmore, *Nuclear Medicine and PET/CT: Technology and Techniques*, 8<sup>th</sup> Ed., St. Louis: Elsevier, 2017, ISBN 978-0-323-35622-0, \$160. (Includes a technologist-level explanation of many NM procedures.)
- Keith F. Eckerman and Akira Endo, *MIRD: Radionuclide Data and Decay Schemes, 2<sup>nd</sup> Edition*, Reston: Society of Nuclear Medicine, 2008, ISBN 978-0-932004-2.
- Rafael C. Gonzalez, and Richard E. Woods, *Digital Image Processing, 4th Edition*, Upper Saddle River, NJ: Pearson Prentice Hall, 2017, ISBN 978-0133356724, \$244.20.
- R.C. Gonzalez, R.E. Woods and S.L. Eddins, *Digital Image Processing Using Matlab*, Upper Saddle River: Pearson Prentice Hall, 2004, ISBN 0-13-008519-X. (Out of print, see [http://www.imageprocessingplace.com/DIPUM-2E/DIPUM2E-Out\\_of\\_Print.htm](http://www.imageprocessingplace.com/DIPUM-2E/DIPUM2E-Out_of_Print.htm).)
- Harold E. Johns and John R. Cunningham, *The Physics of Radiology: Fourth Edition*, Springfield: Thomas, 1983, ISBN 0-398-04669-7.
- Robert Loevinger, et al., *MIRD Primer for Absorbed Dose Calculations, Revised Edition*, Reston: Society of Nuclear Medicine, 1991, ISBN 0-932004-38-5.
- James H. McClellan, Ronald W. Schafer, and Mark A. Yoder, *Signal Processing First: A Multimedia Approach*, Upper Saddle River, NJ: Pearson Education, 2003, ISBN 0-13-090999-8.
- Brian J. McParland, *Nuclear Medicine Radiation Dosimetry: Advanced Theoretical Concepts*, Dordrecht: Springer, 2011, ISBN 978-1-4419-9655-8.
- Jose Maria Perez and Javier Pascau, *Image Processing with ImageJ*, Birmingham, UK: Packt Publishing, 2013, ISBN 978-1783283958.
- Gopal B. Saha, *Fundamentals of Nuclear Pharmacy, Sixth Edition*, New York: Springer Verlag, 2010, ISBN 978-1441958594, \$110.
- Donald Venes, Ed., *Taber's Cyclopedic Medical Dictionary, 22<sup>nd</sup> Edition*, Philadelphia: F.A. Davis, 1989, ISBN 978-0803629776.
- H. Zaidi, Ed., *Quantitative Analysis in Nuclear Medicine Imaging*, New York: Springer, 2006, ISBN 0-387-23854-9, \$134.

## Useful Web Sites:

- Society of Nuclear Medicine and Molecular Imaging, <http://www.snm.org/>
- American Association of Physicists in Medicine, <http://www.aapm.org/>
- Health Physics Society, <http://www.hps.org/>