CUMMING SCHOOL OF MEDICINE
GRADUATE COURSE OUTLINE

COURSE TITLE:	**Medical Imaging Techniques**		
Course	MDSC 689.01		
Pre/Co-Requisites	1) Completion of an honours undergraduate degree in physical, biological or behavioural sciences 2) Completion of first-year university calculus course, and a first-year university physics or chemistry course 3) Enrolment in a MSc or PhD degree program. Priority will be given to students registered in the Medical Imaging Graduate Specialization. Students not registered in the Graduate Specialization/Concentration in Medical Imaging may enrol with permission of the lead instructor, on a space-permitting basis. 4) Students should be competent using basic online tools such as D2L, be able to register accounts in Github.com and ucalgary.syzygy.ca.		
Faculty	Cumming School of Medicine, Graduate Science Education		
Instructor Name(s)	Samuel Pichardo	**Email**	samuel.pichardo@ucalgary.ca
Office Location	Seaman Centre MRG013	**Office Hours**	Wednesdays 2-4pm
Instructor Email Policy	Students are allowed to send email to instructor		
Telephone No.	403 944 5068		
TA Name, if applicable	Danielle Whittier, Deepthi Rajasheka	**Email**	danielle.whittier1@ucalgary.ca deepthi.rajasheka1@ucalgary.ca
Class Term, Days	Fall 2019, Every Monday excepting holidays		
Class Times	3pm – 6pm		
Class Location	HG384		

COURSE INFORMATION/DESCRIPTION OF THE COURSE
MDSC 689.01 – Medical Imaging Techniques - serves as the introductory course in medical imaging for graduate students enrolled in the University of Calgary's Medical Imaging Specialization and the University of Lethbridge's proposed Medical Imaging Graduate Concentration.[1]

1 University of Lethbridge students should enroll in this course with consent of their home program, the course instructor and *via* the Western Deans' Agreement.

http://www.ucalgary.ca/pubs/calendar/grad/current/medical-imaging-medi.htFML for more information on the specialization. The Specialization is currently accessible to graduate students enrolled in Biomedical Engineering, Electrical and Computer Engineering, Medical Sciences, Neurosciences, Physics and Astronomy, and Psychology with permission of the specialization and their home graduate program. Most students require the permission of the Faculty of Medicine Graduate Science Education Office to register to take this course. Other students not in the Medical Imaging Specialization at the University of Calgary may take this course on a space-permitting basis with consent of the instructor.

FML = Fundamentals Modality Lectures – 30-min slot which consists of a lecture highlighting a defined topic and short worked example applying the concept. Questions should be expected from the class during the lecture – allow time for questions. Each FML will likely involve two students – one giving a 15 min introductory lecture on the topic and the other providing a 15-min worked example. It is expected while the lectures will be graded separately, each pair of students will need to develop a coherent lecture.

A **preparatory block time** with the TAs will occur on the week before the FMLs of a given modality. Please prepare in advance a short description (70-100 words) to be reviewed by the TAs.

WE – Written Example – approximately 8-page (maximum) report on a selected advance imaging topic.

E-journal: An article will be posted in D2L the day after the main lecture covering a specialized top on the modality being studied. It is expected students will comment in D2L the following aspects:

- Is the hypothesis clearly stated? Yes/No and why.
- Are methods detailed clearly enough? Yes/No and why.
    - Ask yourself always: Should I be able to repeat the experiment? How many more references I need to consult to gather all details?
- Are results supportive of the hypothesis? Yes/No and why
- Is the Discussion self-critique enough?
    - Are limitations of the study openly addressed?
- How is this article relevant to the modality been studied?
    - Is this study aiming to improve image quality? Is it a new application for the modality?

Groups/individuals working on the same modality or set of FML are **very strongly encouraged** to work together to make a coherent set of lectures and written summaries. At a minimum, this should include sharing lecture outlines and learning objectives, and using a consistent terminology and abbreviations and symbols. A discussion board for each modality will be established on D2L to facilitate communication. Please check and participate in the discussion.

The course outline (below) provides a detailed overview of the workload. Each student will provide:

- *N* (*N* = 2 to 2.5, most likely) oral Fundamentals Modality Lectures (FML) on an assigned topic (Weeks 3 to 12, see outline). Each FML will have a didactic and a worked example component.
- *N* (*N* =1) Written Examples (WE) related on an assigned topic related to an FML (Weeks 3 to 12, see outline)
- Complete a minimum of five of six multi-choice quizzes given in class.

Topics and outlines for each FML and will be provided. Dependent on enrolment, some activities may occur in groups of one, two or three. The workload distribution per student will only be completely determined by the end of Week 2 (**Drop/Add without academic penalty is late September 2019)**.

Course outline:
There are eleven (11) instructional weeks in the Fall 2019 term. Generally, a FML, as well as a WE and/or written CR, will be required from each student every 3-5 weeks. Participation in the E-journal club will be assessed approximately every 2 weeks.
Some of the specifics of the course, such as the FML topics, remain to be determined (TBD) as they are based on the number of students enrolled which will not be finalized until the end of the drop/add period. As mentioned above, it is expected each student to present 2 FMLs. This course outline will be discussed at the start of the first class (Sep 9th).

LEARNING RESOURCES/REQUIRED READING

Reverse taught model.

This course has component of "**reverse-taught**". Students are provided with a framework (overview lectures on basic materials and detailed wiki site) and an outline of specific topics, and are then to present their work *via* a series of oral presentations and lectures, and through the development of written hand-outs, problem examples, and summaries. Medical Imaging Specialization faculty are available to provide guidance and mentorship in advance of lectures, as well as a critical review of the written work. An emphasis during this course will be also placed on self-evaluation and peer-evaluation.

E-journal participation

Students will be required to read scientific material covering specific topics on medical imaging that will be posted in D2L and will be required to participate in online discussion.

Interactive tutorial

Starting the Fall 2019, interactive tutorials based on Python Jupyter Notebooks and **ucalgary.syzygy.ca** infrastructure will be integral part of the learning experience. The students are requested to register accounts to **github.com** and **ucalgary.syzygy.ca.** It is important to clarify that **no programming experience is required** and it is not expected students will be required to write any software during the course**.** No specialized software, other than internet connectivity and modern web browser (Safari, Chrome, Firefox), is required to access and execute the interactive tutorials, which are executed in Compute Canada servers accessible via **ucalgary.syzygy.ca**. However, it is expected students will be competent enough to follow basic instructions how to access the infrastructure and material. It will be acceptable that students can install local installations of Python distributions (Enthought Canopy and Anaconda, both for Python 3.5, are the recommended choices) in their own computers. However, students must keep in mind that instructors and TAs have only the

capacity to certify that material will be fully operational only in the suggested online infrastructure via **ucalgary.syzygy.ca.**

Interactive tutorial assignment. Each tutorial will have a series of questions (5-10) that the students will be able to answer directly in their copy of the tutorial. Students should submit a PDF version of their answers following the calendar outlined below.

Resources (partial listing)

Course Wiki
http://199.116.233.101/index.php/Main_Page

Selected Text Books:

Bailey DL. Positron Emission Tomography: Basic sciences. Springer. 2005. (*available online through library*)

Bharath AA. *Introductory Medical Imaging*. Morgan and Claypool. 2009. (*available online through library*)

Bushberg JT, Seibert JA, Leidholdt EM, Boone JM. The Essential Physics of Medical Imaging, 2nd ed., Lippincott, Williams and Wilkins. 2002.

Buzug, TM. Computed Tomography: From Photon Statistics to Modern Cone-beam CT. Springer. 2008. (*available online through library*)

Cantone MC, Hoeschen C. Radiation Physics for Nuclear Medicine. Springer. 2011. (*available online through library*)

Cherry SR, Phelps ME, Sorenson JA, Sorenson JA. Physics in Nuclear Medicine. 3rd ed. 2003.

Chrysikopoulos HS. Clinical MR Imaging and Physics: A Tutorial. Springer 2009. (*available online through library*)

Cobbold RSC. Foundations of Biomedical Ultrasound. New York: Oxford University Press, 2007.

Curry TS. Christensen's Physics of Diagnostic Radiology. 4th ed. Lea and Febiger, 1990.

Dowsett DJ, Kenny PA, Johnson RE. The Physics of Diagnostic Imaging, 2nd ed. Hodder Arnold, 2006.

Hendee WR, Ritenour ER. Medical Imaging Physics. Wiley 4th ed., 2002.

Hill CR. . Ellis Horwood Series in Applied Physics. Chichester, England: Ellis Horwood, 1986.

Hoskins PR, Martin K, Thrush A. Diagnostic Ultrasound: Physics and Equipment, 2nd ed., Cambridge Medicine, 2010.

Johns HE, Cunningham JR. The Physics of Radiology. 4th ed. Thomas. 1983.

Weishaupt D, Köchli VD, Marincek, B. How Does MRI Work? : An Introduction to the Physics and Function of Magnetic Resonance Imaging: An Introduction to the Physics and Function of Magnetic Resonance Imaging. Springer. 2008. (*available online through library*)

UNIVERSITY OF CALGARY

Selected Papers:

1. Cardiovascular magnetic resonance physics for clinicians: Part II.
   Biglands JD, Radjenovic A, Ridgway JP.
   J Cardiovasc Magn Reson. 2012 Sep 20;14:66. doi: 10.1186/1532-429X-14-66. Review.
   PMID: 22995744 [PubMed - indexed for MEDLINE] **Free PMC Article**
   Related citations
2. Gradient echo imaging.
   Markl M, Leupold J.
   J Magn Reson Imaging. 2012 Jun;35(6):1274-89. doi: 10.1002/jmri.23638. Review.
   PMID: 22588993 [PubMed - indexed for MEDLINE]
   Related citations
3. AAPM/RSNA physics tutorial for residents: physics of flat-panel fluoroscopy systems: Survey of modern fluoroscopy imaging: flat-panel detectors versus image intensifiers and more.
   Nickoloff EL.
   Radiographics. 2011 Mar-Apr;31(2):591-602. doi: 10.1148/rg.312105185.
   PMID: 21415199 [PubMed - indexed for MEDLINE] **Free Article**
   Related citations
4. Cardiovascular magnetic resonance physics for clinicians: part I.
   Ridgway JP.
   J Cardiovasc Magn Reson. 2010 Nov 30;12:71. doi: 10.1186/1532-429X-12-71. Review.
   PMID: 21118531 [PubMed - indexed for MEDLINE] **Free PMC Article**
   Related citations
5. Anniversary paper: evaluation of medical imaging systems.
   Krupinski EA, Jiang Y.
   Med Phys. 2008 Feb;35(2):645-59. Review.
   PMID: 18383686 [PubMed - indexed for MEDLINE]
   Related citations
6. ROC analysis in medical imaging: a tutorial review of the literature.
   Metz CE.
   Radiol Phys Technol. 2008 Jan;1(1):2-12. doi: 10.1007/s12194-007-0002-1. Epub 2007 Oct 27. Review.
   PMID: 20821157 [PubMed - indexed for MEDLINE]
   Related citations
7. AAPM/RSNA physics tutorial for residents: Technologic advances in multidetector CT with a focus on cardiac imaging.
   Cody DD, Mahesh M.
   Radiographics. 2007 Nov-Dec;27(6):1829-37. Review.
   PMID: 18025521 [PubMed - indexed for MEDLINE] **Free Article**
   Related citations
8. SimpleDICOM suite: personal productivity tools for managing DICOM objects.
   Branstetter BF 4th, Uttecht SD, Lionetti DM, Chang PJ.
   Radiographics. 2007 Sep-Oct;27(5):1523-30. Review.
   PMID: 17848708 [PubMed - indexed for MEDLINE] **Free Article**
   Related citations
9. Basics of imaging informatics: part 2.
   Branstetter BF 4th.
   Radiology. 2007 Jul;244(1):78-84. Review.
   PMID: 17581896 [PubMed - indexed for MEDLINE] **Free Article**
   Related citations
10. Basics of imaging informatics. Part 1.
    Branstetter BF 4th.
    Radiology. 2007 Jun;243(3):656-67. Epub 2007 Apr 12. Review.
    PMID: 17431128 [PubMed - indexed for MEDLINE] **Free Article**
    Related citations

11. Diagnostic imaging over the last 50 years: research and development in medical imaging science and technology.
Doi K.
Phys Med Biol. 2006 Jul 7;51(13):R5-27. Epub 2006 Jun 20. Review.
PMID: 16790920 [PubMed - indexed for MEDLINE]
Related citations

12. MR pulse sequences: what every radiologist wants to know but is afraid to ask.
Bitar R, Leung G, Perng R, Tadros S, Moody AR, Sarrazin J, McGregor C, Christakis M, Symons S, Nelson A, Roberts TP.
Radiographics. 2006 Mar-Apr;26(2):513-37. Review.
PMID: 16549614 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

13. AAPM/RSNA physics tutorial for residents: MR artifacts, safety, and quality control.
Zhuo J, Gullapalli RP.
Radiographics. 2006 Jan-Feb;26(1):275-97. Review.
PMID: 16418258 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

14. AAPM/RSNA physics tutorial for residents: fundamental physics of MR imaging.
Pooley RA.
Radiographics. 2005 Jul-Aug;25(4):1087-99.
PMID: 16009826 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

15. AAPM/RSNA physics tutorial for residents: technological and psychophysical considerations for digital mammographic displays.
Samei E.
Radiographics. 2005 Mar-Apr;25(2):491-501. Review.
PMID: 15798066 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

16. AAPM/RSNA physics tutorial for residents: digital mammography: an overview.
Mahesh M.
Radiographics. 2004 Nov-Dec;24(6):1747-60.
PMID: 15537982 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

17. AAPM/RSNA physics tutorial for residents: topics in US: beyond the basics: elasticity imaging with US.
Hall TJ.
Radiographics. 2003 Nov-Dec;23(6):1657-71. Review.
PMID: 14615571 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

18. AAPM/RSNA physics tutorial for residents: topics in US: Doppler US techniques: concepts of blood flow detection and flow dynamics.
Boote EJ.
Radiographics. 2003 Sep-Oct;23(5):1315-27. Review.
PMID: 12975518 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

19. AAPM/RSNA physics tutorial for residents. Topics in US: B-mode US: basic concepts and new technology.
Hangiandreou NJ.
Radiographics. 2003 Jul-Aug;23(4):1019-33. Review.
PMID: 12853678 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

20. AAPM/RSNA Physics Tutorial for Residents: Topics in CT. Radiation dose in CT.
McNitt-Gray MF.
Radiographics. 2002 Nov-Dec;22(6):1541-53. Review.
PMID: 12432127 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

21. AAPM/RSNA physics tutorial for residents: topics in CT. Image processing in CT.
Cody DD.

Radiographics. 2002 Sep-Oct;22(5):1255-68. Review.
PMID: 12235351 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

22. The AAPM/RSNA physics tutorial for residents: digital fluoroscopy.
Pooley RA, McKinney JM, Miller DA.
Radiographics. 2001 Mar-Apr;21(2):521-34.
PMID: 11259716 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

23. The AAPM/RSNA physics tutorial for residents: fluoroscopy: optical coupling and the video system.
Van Lysel MS.
Radiographics. 2000 Nov-Dec;20(6):1769-86. Review.
PMID: 11112828 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

24. The AAPM/RSNA physics tutorial for residents: X-ray image intensifiers for fluoroscopy.
Wang J, Blackburn TJ.
Radiographics. 2000 Sep-Oct;20(5):1471-7. Review.
PMID: 10992034 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

25. The AAPM/RSNA physics tutorial for residents: general overview of fluoroscopic imaging.
Schueler BA.
Radiographics. 2000 Jul-Aug;20(4):1115-26.
PMID: 10903700 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

26. The AAPM/RSNA physics tutorial for residents: internal radiation dosimetry: principles and applications.
Toohey RE, Stabin MG, Watson EE.
Radiographics. 2000 Mar-Apr;20(2):533-46; quiz 531-2.
PMID: 10715348 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

27. The AAPM/RSNA physics tutorial for residents. MR imaging safety considerations. Radiological Society of North America.
Price RR.
Radiographics. 1999 Nov-Dec;19(6):1641-51. Review.
PMID: 10555679 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

28. The AAPM/RSNA physics tutorial for residents. Typical patient radiation doses in diagnostic radiology.
Parry RA, Glaze SA, Archer BR.
Radiographics. 1999 Sep-Oct;19(5):1289-302.
PMID: 10489180 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

29. The AAPM/RSNA physics tutorial for residents. Radiopharmaceuticals.
Ponto JA.
Radiographics. 1998 Nov-Dec;18(6):1395-404.
PMID: 9821190 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

30. The AAPM/RSNA physics tutorial for residents. X-ray interactions.
Bushberg JT.
Radiographics. 1998 Mar-Apr;18(2):457-68.
PMID: 9536489 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

31. The AAPM/RSNA physics tutorial for residents. X-ray attenuation.
McKetty MH.
Radiographics. 1998 Jan-Feb;18(1):151-63; quiz 149.
PMID: 9460114 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

32. The AAPM/RSNA physics tutorial for residents. X-ray generators.

Seibert JA.
Radiographics. 1997 Nov-Dec;17(6):1533-57. Erratum in: Radiographics. 1998 Nov-Dec;18(6):1340-1.
PMID: 9397462 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

33. The AAPM/RSNA physics tutorial for residents. X-ray production.
McCollough CH.
Radiographics. 1997 Jul-Aug;17(4):967-84.
PMID: 9225393 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

34. The AAPM/RSNA physics tutorial for residents. Measures of screen-film performance.
Haus AG.
Radiographics. 1996 Sep;16(5):1165-81.
PMID: 8888396 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

35. The AAPM/RSNA physics tutorial for residents. Clinical aspects of emission tomography.
Miller TR.
Radiographics. 1996 May;16(3):661-8. Review.
PMID: 8897630 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

36. The AAPM/RSNA physics tutorial for residents. Physics of SPECT.
Tsui BM.
Radiographics. 1996 Jan;16(1):173-83. Review.
PMID: 10946698 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

37. The AAPM/RSNA physics tutorial for residents. Physics of PET.
Votaw JR.
Radiographics. 1995 Sep;15(5):1179-90.
PMID: 7501858 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

38. The AAPM/RSNA physics tutorial for residents. Introduction to emission CT.
Madsen MT.
Radiographics. 1995 Jul;15(4):975-91.
PMID: 7569142 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

39. The AAPM/RSNA physics tutorial for residents. An introduction to MR angiography.
Saloner D.
Radiographics. 1995 Mar;15(2):453-65.
PMID: 7761648 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

40. The AAPM/RSNA physics tutorial for residents. Contrast mechanisms in gradient-echo imaging and an introduction to fast imaging.
Price RR.
Radiographics. 1995 Jan;15(1):165-78; quiz 149-50.
PMID: 7899595 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

41. The AAPM/RSNA physics tutorial for residents. Contrast mechanisms in spin-echo MR imaging.
Plewes DB.
Radiographics. 1994 Nov;14(6):1389-404; quiz 1405-6.
PMID: 7855348 [PubMed - indexed for MEDLINE] **Free Article**
Related citations

42. The AAPM/RSNA physics tutorial for residents. Basic physics of MR imaging: an introduction.
Hendrick RE.
Radiographics. 1994 Jul;14(4):829-46; quiz 847-8.
PMID: 7938771 [PubMed - indexed for MEDLINE] **Free Article**

Related citations

44. Ultrasound contrast agents: an overview.
Cosgrove D
Eur J Radiol. 2006 Dec;60(3):324-30. Epub 2006 Aug 30
PMID: 16938418 [Indexed for MEDLINE]
45. A Primer on the Physical Principles of Tissue Harmonic Imaging.
Anvari A, Forsberg F, Samir AE.
Radiographics. 2015 Nov-Dec;35(7):1955-64. doi: 10.1148/rg.2015140338.
PMID: 16938418 [Indexed for MEDLINE]

COURSE OBJECTIVES/LEARNING OUTCOMES

This course provides a comprehensive introduction to the field of clinical medical imaging, with a focus on the underlying technologies. The course surveys the principal clinical imaging modalities (x-ray (XR), computed tomography (CT), magnetic resonance (MR), nuclear medicine (NM) including single photon emission computed tomography (SPECT) and positron emission tomography (PET), and ultrasound (US) that are used in a modern diagnostic imaging department. The course covers both the underlying physical principles, the technological implementation, and basic clinical applications of each modality. There is a focus on fundamentals of each imaging technology.

Learning objectives:

1. To develop a firm foundation in medical imaging technologies that will provide a suitable basis for other foundational and elective courses in the Graduate Specialization/Concentration and assist you with your research work.
2. To enhance teaching, oral and written presentation skills, and team work skills that will support successful progression through the Specialization/Concentration.
3. To get familiar with modern software tools for imaging analysis

Suggested teaching model: The model that we will use for lectures is called “BOPPPS”. BOPPPS stands for ***b**ridge, **o**bjective, **p**re-test, **p**articipatory learning, **p**ost-test, **s**ummary*. It is one of a number of teaching rubrics that brings a structured and consistent approach to teaching. Please make explicit use of this rubric for purposes of this class. A summary of BOPPS can be found at http://hlwiki.slais.ubc.ca/index.php/BOPPPS_Model. Please review these recommendations. One of the key elements to BOPPS is to include active, participatory learning in your teaching. With participatory learning, your “students” are much more likely to remember what you said, and also to have enjoyed the process. The BOPPS principle can also be used in generating effective teaching sessions.

The use of interactive tutorials and assignments using Python Jupyter Notebooks and **ucalgary.syzygy.ca** infrastructure has multiple learning goals including:

1) Provide a direct hands-on opportunity to practice basic concepts on medical imaging

2) Getting familiar with basic tools for handling of medical imaging
3) Getting familiar with the Jupyter Notebook technology, which is becoming a dominant platform for medical imaging processing
4) Students will be invited to keep copies of the Jupyter Notebooks for their own use beyond the course, as these notebooks will contain source code software that students may find useful for their own research projects
5) Students will be invited to improve the material, if they are willing to do so, via collaborative tools such as github.com, and a supplemental extra grading (up to 5%) will be offered for students willing to participate in improving the content

CUT POINTS FOR GRADES

This course adheres to the grading system outlined in the University of Calgary, Faculty of Graduate Studies Calendar. Grades of A+ and A are not distinguished in the calculation of GPAs. Percentage/letter grade conversion used for this course is as follows

Grade	Grade Point Value	Percentage Conversion	Graduate Description
A+	4.00	95-100	Outstanding
A	4.00	90-94	Excellent – superior performance showing comprehensive understanding of the subject matter
A-	3.70	85-89	Very Good Performance
B+	3.30	77-84	Good Performance
B	3.00	72-76	Satisfactory Performance
B-	2.70	68-71	Minimum Pass for Students in the Faculty of Graduate Studies
C+	2.30	63-67	All grades below 'B-" are indicative of failure at the graduate level and cannot be counted toward Faculty of Graduate Studies course requirements

Assessment Components: The University policy on grading related matters is outlined in the 2019-2020 Calendar.

Assessment Methods	Description	Weight %	Due Date and Time

Quizzes	6, approx. every 2 week, best 5 quizzes count for 5% each	25	See calendar outline below for dates.
Fundamentals Modality Lecture (FML)	*N* = TBD, depending on enrollment, 2 most likely	30	See calendar outline below.
Written Example (WE)	One approximately 8-page (maximum) report on a selected advance imaging topic	20	Nov 22nd , 16h
E-journal Discussion Contribution (quality and quantity) 10%	5 suggested readings via D2L will posted and students should participate via D2L, the discussion will remain open until one week after the last class session	10	Dec 9th, 20h
Assignments on online tutorial	6, Each online tutorial includes questions to be answered by the students, who must submit their answer 5 days after the tutorial	15	See calendar outline below for dates.
Bonus	A supplemental extra grading will be offered for students willing to participate in improving the content in github.	Up to 5%	

ASSESSMENT AND EVALUATION INFORMATION

ATTENDANCE AND PARTICIPATION EXPECTATIONS:

The lead instructor should be informed by e-mail of any requests for accommodation (including required absences) by the end of class in the second week. It is expected that you will attend all classes over the term. Failure to attend the lectures may result in a failing grade.

GUIDELINES FOR SUBMITTING ASSIGNMENTS:

Topics and course outlines for each presentation, lecture, and critique, as well as the written contributions will be provided. Dependent on enrolment, most activities will occur in groups of one, two or three.

Stated page lengths (below) assume double-spaced text, 12-point font, 1 cm margins and are exclusive of figures and references. Both figures and references are required in written components.

Avoid acquisitions of plagiarism – see page **Error! Bookmark not defined.** – ensure that all materials in presentations and in written submissions have proper attribution. Be cognizant of copyright – see page **Error! Bookmark not defined.** – do not reproduce copyright protected material and where possible, redraw figures based on another source (in this case ensure that you give proper attribution by stating that your figure is 'Adapted from …", *etc*.).

Interactive tutorial assignment. Each tutorial will have a series of questions (5-10) that the students will be able to answer directly in their copy of the tutorial. Students should submit a PDF version of their answers following the calendar outlined above.

Oral Presentations:

Manage your allocated time well. Do not go over time. Generally insufficient time is allocated to cover the complete topic. In your oral presentations you need to extract key ideas and present them as an executive summary of the assigned topic. A written handout to accompany the lecture is required. Allow time for questions.

Fundamentals Modality Lecture (FML; *N = 2 to 2.5* over Weeks 3-13)

- **30-min** modality lecture on the assigned topic
- Expect at least 5 min to be spent on questions and clarifications during your FML
- You should only use PowerPoint if the covered content aligns itself with this form of presentation. Please consider using the white board or another lecture form.
- By 16h Friday before your FML, please provide your handout in electronic form (PDF) to the instructor to post on D2L for the class to access.
- Follow the BOPPPS or similar teaching rubric (see information on page 9).
- At the end of each FML please provide your materials in electronic form (PDF) to the instructor to post on D2L.

FINAL EXAMINATIONS:
N/A

EXPECTATIONS FOR WRITING:
Written Examples:

Please use the *Radiology* journal Publication Information for Authors (see http://radiology.rsna.org/site/pia/manprep.xhtFML) as a general style guide with respect to:

- Text Formatting
- Units and Abbreviations
- References
- Tables
- Figures (except that you are to submit multi-part figures as a combined figures)
- Captions

You do not need to follow the *Radiology* Publication Information for Authors with respect to: Title Pages, Main Body (you will however need an *Introduction* and a *Summary* section, but otherwise are free to choose your own headings and subheadings), Summary Statement, Word Count (note there are page limits provided below), Appendix, Acknowledgements, or Supplemental Material.

Keep in mind that the intent at the end of this course is to produce supplemental material that will appear on-line (as part of the wiki pages). For this reason, it is required that we do not use copyrighted material in your written example submissions

LATE AND/OR MISSING ASSIGNMENTS:
A penalty of 50% of the assigned percentage associated to the item (WE, online interactive tutorial assignment and FML) will be applied if student(s) submit their work up to 48 hrs after the date limit detailed in the outline. Any further delay beyond 48 hrs the assignment will be considered as missed.

For the quizzes, and in recognition students often need to balance out of campus activities such as conferenced attendance, only the best 5 of the 6 quizzes will be used in the final assessment.

Is a passing grade on a particular component essential to pass the course as a whole? N/A

	COURSE TIMETABLE		
Course Schedule Date	**Topic & Reading**	**Instructor**	**Assignments/Due Dates & Times**
Sep 9th (W1)	Introduction to course, review of course learning objectives and expectations and anticipated workload Introduction to medical imaging terminology, basic concepts, and evaluation of medical imaging systems Interactive Tutorial on DICOM file format	Pichardo	**Assignment** on Tutorial on DICOM file image format (due 16h Sep 13th) **E-journal discussion** is required throughout the term and will be assessed for each block.
Sep 16th (W2)	**Block 1 – X-ray (XR)** Introductory Lecture (50 min) Interactive Tutorial on Signal and Image Processing (60 min) *Block Xray Preparation (30 min)*	 Whittier Pichardo *Block X ray lecturers*	**Hand-outs for W3 FML (X-ray)** (due 16h Fri 22 Sep on D2L; only students giving a lecture in W3) **Assignment** on Signal and Image Processing (due 16h Sep 20th)
Sep 23th (W3)	**Quiz 1 - Introduction to medical imaging and processing (20min)** FML XR.1 (30 min) FML XR.2 (30 min) –	Pichardo	**Quiz on Introduction to medical imaging and processing**

	FML XR.3 (30 min) Interactive Tutorial on X Rays (50 min) – Xrays	Whittier	**Assignment** on Xray (due 16h Sep 20th)
Sep 30th (W4)	**Quiz 2 – X rays (20 min)** **Block 2 – Computed Tomography (CT)** Introductory Lecture (50 min) *Block CT Preparation (30 min)*	Manske *Block CT Lecturers*	**Quiz on X rays** **Hand-outs for W5 FML** (due 16h Fri Oct 12th on D2L; only students giving a lecture in W5)
Oct 7th (W5)	**Announce of Written Example (WE) topic** FML CT.1 (30 min) – FML CT.2 (30 min) – FML CT.3 (30 min) – Interactive Tutorial on CT (60 min) – Xrays	Pichardo Manske	**Written Example** (due 16h Fri Nov 22nd on D2L) **Assignment** on CT (due 16h Oct 12th)
Oct 14th (W6)	**Thanksgiving Holiday**		
Oct 21th (W7)	**Quiz 3 – CT (20 min)** **Block 3 – Magnetic Resonace Imaging (MRI)** Introductory Lecture (50 min) *Block MRI Preparation (30 min)*	Deepthi *Block MRI lecturers*	**Quiz on CT** **Hand-outs for W8 FML** (due 16h Fri Oct 25th on D2L; only students giving a lecture in W8)
Oct 28th (W8)	FML MR.1 (30 min)– FML MR.2 (30 min) – FML MR.3 (30 min) – Interactive Tutorial on MRI (60 min)	Deepthi	**Assignment** on MRI (due 16h Nov 1st)
Nov 4th (W9)	**Quiz 3 – MRI (20 min)** **Block 4 – Nuclear Medicine (NM)**	Stewart Pichardo	**Hand-outs for W11 FML** (due 16h Fri Nov 5th on D2L; only students giving a lecture in W11)

	Introductory Lecture (50 min) **Block 5 – Ultrasound (US)** Introductory Lecture (50 min) *Block NM Preparation (30 min)*		
Nov 11th (W10)	**Term break**		
Nov 18th (W11)	FML NM.1 (30 min) FML NM.2 (30 min) FML NM.3 (30 min) Interactive Tutorial on NM (60 min) *Block US Preparation (30 min)*	*Block NM lecturers* Pichardo	**Written Example (WE)** (due 16h Fri Nov 22nd on D2L) **Assignment** on NM (due 16h Nov 1st) **Hand-outs for W12 FML** (due 16h Fri Nov 22nd on D2L; only students giving a lecture in W12)
Nov 25th (W12)	**Quiz 4 – NM (20 min)** FML US.1 (30 min) FML US.1 (30 min) FML US.3 (30 min) Interactive Tutorial on US (60 min)	*Block US lecturers* Pichardo	**Quiz on NM** **Assignment** on US (due 16h Nov 29th)
Dec 2th (W13)	**Quiz 5 – US (20 min)** Interactive Tutorial Summary of Concepts (60 min) *Open discussion of learning experience (60 min)*	Pichardo	**Quiz on US**

INTERNET AND ELECTRONIC COMMUNICATION DEVICE INFORMATION
Cell phones must be turned off in class unless otherwise arranged with the instructor. The use of laptop and mobile devices is acceptable when used in a manner appropriate to the course and classroom activities. Students are to refrain from accessing websites that may be distracting for fellow learners (e.g. personal emails, Facebook, YouTube). Students are responsible for being aware of the

University's Internet and email use policy, which can be found at https://www.ucalgary.ca/policies/files/policies/electronic-communicationspolicy.pdf.

MEDIA AND RECORDING IN LEARNING ENVIRONMENTS

Media recording for lesson capture

The instructor may use media recordings to capture the delivery of a lecture. These recordings are intended to be used for lecture capture only and will not be used for any other purpose. Although the recording device will be fixed on the Instructor, in the event that incidental student participation is recorded, the instructor will ensure that any identifiable content (video or audio) is masked, or will seek consent to include the identifiable student content to making the content available on University approved platforms.

Media recording for assessment of student learning

The instructor may use media recordings as part of the assessment of students. This may include but is not limited to classroom discussions, presentations, clinical practice, or skills testing that occur during the course. These recordings will be used for student assessment purposes only and will not be shared or used for any other purpose.

Media recording for self-assessment of teaching practices

The instructor may use media recordings as a tool for self-assessment of their teaching practices. Although the recording device will be fixed on the instructor, it is possible that student participation in the course may be inadvertently captured. These recordings will be used for instructor self-assessment only and will not be used for any other purpose.

Student Recording of Lectures

Audio or video recording of lectures is prohibited except where explicit permission has been received from the instructor.

UNIVERSITY OF CALGARY POLICIES AND SUPPORTS

ACADEMIC ACCOMMODATIONS

Students seeking an accommodation based on disability or medical concerns should

IMPORTANT INFORMATION

Any research in which students are invited to participate will be explained in class and approved by the appropriate University Research Ethics Board

INSTRUCTOR INTELLECTUAL PROPERTY

Course materials created by professor(s) (including course outlines, presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the professor(s). These materials may NOT be reproduced, redistributed or copied without the explicit consent of the professor. The posting of course materials to third party websites such as note-sharing sites without permission is prohibited. Sharing

of extracts of these course materials with other students enrolled in the course at the same time may be allowed under fair dealing.

COPYRIGHT LEGISLATION
All students are required to read the University of Calgary policy on Acceptable Use of Material Protected by Copyright (www.ucalgary.ca/policies/files/policies/acceptable-use-of-material-protected-by-copyright.pdf) and requirements of the copyright act (https://laws-lois.justice.gc.ca/eng/acts/C-42/index.html) to ensure they are aware of the consequences of unauthorised sharing of course materials (including instructor notes, electronic versions of textbooks etc.). Students who use material protected by copyright in violation of this policy may be disciplined under the Non-Academic Misconduct Policy.

ACADEMIC INTEGRITY
The Cumming School of Medicine expects intellectual honesty from its students. Course participants should be aware of University policies relating to Principles of Conduct, Plagiarism and Academic Integrity. These are found in the printed Faculty of Graduate Studies Calendar, or online under Academic Regulations in the Faculty of Graduate Studies Calendar, available at **Faculty of Graduate Studies Academic Regulations**

ACADEMIC MISCONDUCT
For information on academic misconduct and its consequences, please see the University of Calgary Calendar at http://www.ucalgary.ca/pubs/calendar/current/k.html

EMERGENCY EVACUATION AND ASSEMBLY POINTS
Assembly points for emergencies have been identified across campus. The primary assembly points for South Campus (Health Science Centre (HSC); Health & Research Innovation Centre (HRIC); Heritage Medical Research Building (HMRB) and Teaching, Research and Wellness (TRW)) are:

- HSC and HMRB: HRIC Atrium (alternate assembly point is Parking Lot 6)
- HRIC: HMRB Atrium (alternate assembly point is Parking Lot 6)
- TRW: McCaig Tower (alternate assembly point is HMRB – Atrium)

APPEALS
If there is a concern with the course, academic matter or a grade, first communicate with the instructor. If these concerns cannot be resolved, students can proceed with an academic appeal, as per Section N of the Faculty of Graduate Studies Calendar. Students must follow the official process and should contact the Student Ombuds Office (http://www.ucalgary.ca/provost/students/ombuds) for assistance with this and with any other academic concerns, including academic and non-academic misconduct

THE FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY (FOIP) ACT
This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIP) and students should identify themselves on written assignments (exams and term work.) by their name and ID number on the front page and ID on each subsequent page. Assignments given by you to your course instructor will remain confidential unless otherwise stated before submission. The assignment cannot be returned to anyone else without your expressed permission to the instructor. Grades will be made available on an individual basis and students will not have access to other students' grades without expressed consent.

Similarly, any information about yourself that you share with your course instructor will not be given to anyone else without your permission

WELLNESS AND MENTAL HEALTH RESOURCES

The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the excellent mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU Wellness Centre (Room 370, MacEwan Student Centre), https://www.ucalgary.ca/wellnesscentre/services/mental-health-services and the Campus Mental Health Strategy website https://www.ucalgary.ca/mentalhealth/"

SUPPORTS FOR STUDENT LEARNING, SUCCESS, AND SAFETY

Student Ombudsman: The Student Ombuds' Office supports and provides a safe, neutral space for students. For more information, please visit www.ucalgary.ca/ombuds/ or email ombuds@ucalgary.ca

Student Union: The SU Vice-President Academic can be reached at (403) 220-3911 or suvpaca@ucalgary.ca; Information about the SU, including elected Faculty Representatives can be found here: https://www.su.ucalgary.ca

Graduate Student's Association: The GSA Vice-President Academic can be reached at (403) 220- 5997 or gsa.vpa@ucalgary.ca; Information about the GSA can be found here: https://gsa.ucalgary.ca

SAFEWALK

Campus security will escort individuals, day or night, anywhere on campus (including McMahon Stadium, Health Sciences Centre, Student Family Housing, the Alberta Children's Hospital and the University LRT station). Call 403-220-5333 or visit http://www.ucalgary.ca/security/safewalk. Use any campus phone, emergency phone or the yellow phone located at most parking lot pay booths. Please ensure your personal safety by taking advantage of this service.