CUMMING SCHOOL OF MEDICINE
GRADUATE COURSE OUTLINE

COURSE TITLE:			
Course	MDSC 689.01, Medical Imaging Techniques		
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, online conferencing tools (Zoom, Microsoft Teams), and 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**	Thursdays 2-4pm, **zoom-only** meeting. Please contact via email in advance to prepare zoom session.
Instructor Email Policy	Students are allowed to send email to Instructor		
Telephone No.	403 944 5068		
TA Name, if applicable	Deepthi Rajashekar	**Email**	deepthi.rajasheka1@ucalgary.ca
Class Term, Days	Fall 2020, Every Wednesday excepting holidays		
Class Times	3pm – 6pm		
Class Location	Zoom online.		

This course will take place **online** via Desire2Learn (D2L) and Zoom via synchronous instruction. To best succeed in the course, students are encouraged to participate in the synchronous Zoom sessions**.** When unable to participate live due to the time difference or unforeseen circumstances, inform the instructor in advance and propose and implement propose an alternative participation activity

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] 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 approval 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 the 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.

IMPORTANT

To ensure lectures meet the expectations of the topic to cover, the lecturers for a given FML have the **mandatory** requirement to meet with the TA or course coordinator to screen their material at least **6-7 days** before their presentation. Students will have 2 weeks between the introductory talk and the FML presentation to prepare their content. Failing screening the material for the lecture will translate into a penalty of a reduction of 20% in the grading score for their FMLs presentation. It is then highly recommended the lecturers take enough time to prepare their material.

A **preparatory block time** with the TA will occur two weeks before the FMLs of a given modality, shortly after the introductory talk. 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. There will be also a final 5 min presentation on the last day of classes to summarize the report.

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?

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.

- Are the 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 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 4 to 14, 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 wholly determined by the end of Week 2 (**Drop/Add without academic penalty is late September 2020)**.

Course outline:
There are eleven (14) instructional weeks in the Fall 2020 term. Generally, an FML, as well as a WE, will be required from each student every 3-5 weeks. As noted below, each modality has an online tutorial where students will have the opportunity to use dynamic content to review some concepts. Each tutorial will have a simple assignment to be completed in the week following the tutorial.

Once the material of a modality is completed, a 20-min quiz (10-15 simple questions max.) will take the **following week during class via d2l**.

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 for 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 a component of "**reverse-taught**". Students are provided with a framework (overview lectures on primary materials and detailed wiki site) and an outline of specific topics. Students then present their work *via* a series of oral presentations and lectures, and through the development of written handouts, 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. Emphasis during this course will also be 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 the online discussion.

Interactive tutorial

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 in **github.com** and **ucalgary.syzygy.ca.** It is essential 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 on how to access the infrastructure and material. It will be acceptable that students install local installations of Python distributions (Enthought Canopy and Anaconda, both for Python 3.5 and up, are the recommended choices) in their own computers. However, students must keep in mind that instructors and TA 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*)

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 27th. 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 12th. 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 7th;51(13):R5-27. Epub 2006 Jun 20th. 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 30th
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 the 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 an extra supplemental grading (up to 5%) will be offered for students willing to participate in improving the content

Communication

Brightspace (By D2L) is located on the University of Calgary server and will be used extensively for communication with Students. A link to the zoom class will be provided on D2L. It is the student's responsibility to ensure that they receive all posted communications and documents and that they receive e-mails send by instructors of fellow students through D2L. Only your @ucalgary.ca e-mail address maybe linked to D2L. Please ensure that you are regularly checking your @ucalgary.ca account

Learning Technology Requirements

In order to successfully engage in learning experiences at the University of Calgary, students taking online, remote and blended courses are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security and malware updates;
- A current and updated web browser;
- Webcam (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Broadband internet connection

Most current laptops will have a built-in webcam, speaker and microphone.

Please see the following for a detailed explanation of the minimal required technology for online learning https://elearn.ucalgary.ca/technology-requirements-for-students/

A laptop, desktop, tablet or mobile device is required for D2L access. If you need help accessing or using D2L, please visit the Desire2Learn resource page for students: http://elearn.ucalgary.ca/d2l-student/.

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 the calendar outline below. Please review details carefully above conditions to review material one week before FML presentations.

Written Example (WE)	One approximately 8-page (maximum) report on a selected advance imaging topic; 15/20 points. Individual Final presentation (5 min) to peers on last day of class; 5/20 points	20: 15 points for the report and 5 points for the final presentation.	Nov 22nd , 16h for written report, and Dec 9th for final presentation
E-journal Discussion Contribution (quality and quantity) 10%	5 suggested readings via D2L will be 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 the calendar outline below for dates.
Bonus	An extra supplemental 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 email of any requests for accommodation (including required absences) by the end of class in the second week. It is expected that the students 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 – read below – ensure that all materials in presentations and in written submissions have a proper attribution. Be cognizant of copyright – read below – 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 …", e*tc*.).

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 can use PowerPoint if the covered content aligns itself with this form of presentation. Given the online modality of the course, this is the default modality. However, we invite students to explore different virtual modalities, just be sure of practicing with enough time to be sure the experience will be up to expectations. Do not hesitate to reach the TA or Instructor to review different types of contents. Also, consider using the zoom features such as polling to interact with your audience.
- By 16h Tuesday 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 online (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 the 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.

As noted in the FML description above, students must screen their material 6-7 days before their presentation so TA or Instructor can provide feedback so students can improve their material.

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, and important action items**
Sep 9th (W1)	Introduction to course, review of course learning objectives and expectations and anticipated workload Introduction to medical imaging terminology and basic concepts 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. **Assignments on FIPs during class**
Sep 16th (W2)	**Ultrasound (US)** Introductory Lecture (50 min) **Interactive Tutorial** on Signal and Image Processing (40 min)	Pichardo	**Handouts for W4 FML (US),** due noon Tue Sep 29th on D2L; only students giving a lecture in W4

	Demo FML (30 min) *Block US Preparation (30 min)*	 *Block US lecturers*	**Tutorial Assignment** on Signal and Image Processing ; due 16h Sep 22th
Sep 23th (W3)	**Quiz 1 - Introduction to medical imaging (20min)** **X-ray (XR)** Introductory lecture (50 min) *Block Xray Preparation (30 min)*	 Whittier *Block X ray lecturers*	**Quiz** on Introduction to medical imaging and processing **Handouts for W5 FML (XRay),** due noon Tue Oct 6th on D2L; only students giving a lecture in W4
Sep 30th (W4)	FML US.1 (30 min) FML US.1 (30 min) FML US.3 (30 min) Interactive Tutorial on US (60 min)	Pichardo	**Tutorial Assignment** on US ; due 16h Oct 6th
Oct 7th (W5)	**Quiz 2 – US (20 min)** FML XR.1 (30 min) FML XR.2 (30 min) FML XR.3 (30 min) Interactive Tutorial on X Rays (50 min) – Xrays	 Whittier	**Quiz on US** **Tutorial Assignment** on Xray; due 16h Oct 13th
Oct 14th (W6)	**Quiz 3– Xray (20 min)** **Computed Tomography (CT)** Introductory lecture (50 min) *Block CT Preparation (30 min)*	 Manske *Block CT Lecturers*	**Quiz on X rays** **Handouts for W8 FML** (**CT**) due Tue noon Oct 27th on D2L; only students giving a lecture in W8)
Oct 21th (W7)	**Announce of Written Example (WE) topic** **Nuclear Medicine (NM)** Introductory lecture (50 min)	Stewart	**Written Example** (due 16h Fri Nov 25th on D2L) **Handouts for W8 FML** (**NM**) due Tue noon Oct 27th on D2L;

	Block NM Preparation (30 min)	*Block CT Lecturers*	only students giving a lecture in W9)
Oct 28th (W8)	FML CT.1 (30 min) – FML CT.2 (30 min) – FML CT.3 (30 min) – Interactive Tutorial on CT (50 min) – Xrays	Manske Manske	**Tutorial Assignment** on CT; due 16h Nov 3rd
Nov 4th (W9)	**Quiz 4– CT (20 min)** FML NM.1 (30 min) FML NM.2 (30 min) FML NM.3 (30 min) Interactive Tutorial on NM (60 min)	Pichardo	**Quiz on CT** **Tutorial Assignment** on NM; due 16h Nov 17th
Nov 11th (W10)	**Term break**		
Nov 18th (W11)	**Quiz 5 – NM (20 min)** **Magnetic Resonance Imaging (MRI)** Introductory lecture (50 min) *Block MRI Preparation (30 min)*	 Deepthi *Block MRI lecturers*	**Quiz on NM** **Handouts for W13 FML** (MRI) due Tue noon Dec 1st on D2L; only students giving a lecture in W9)
Nov 25th (W12)	Special topic – Image guided non-invasive interventions	Pichardo	**Written Example (WE)** (due 16h Fri Nov 22nd on D2L)
Dec 2th (W13)	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 Dec 8th)
Dec 9th (W14)	**Quiz 6 – MRI (20 min)** **WE presentation**	Pichardo All students	**Quiz on MRI**

"ZOOM" CODE OF CONDUCT and TIPS

The invited speakers, your peers presenting, TA and Instructor are doing their best to provide the best learning experience. Please consider the following simple guidelines while attending our class via zoom:

1. As in-person classes, be always considerate to your peers and instructors.
2. We will share via D2L and email, the password for the class sessions. PLEASE DO NOT share this password with anyone unless previously arranged with the Instructor.
3. Please keep your video feed active unless being instructed to turn off. Presenters appreciate being able to visualize the face and reactions of the audience they are addressing.
4. When not speaking, please mute your microphone.
5. Use zoom tools such as "raise hand" for critical comments or questions. Allow the TA and Instructor to take note of your raised hand to instruct the presenter that an important comment is desired to be addressed.
6. Use the chat to ask questions that can be answered at the end of the presentation. The chat is excellent to make questions that do not need to interrupt the presenter; use it to post questions while the talk is developing.

The zoom platform has many amenities that we highly recommend you explore using at its maximum to ensure you can have an excellent learning experience. Here we just mention a few of the ones you could consider:

1. Use of breakout rooms. There may be instances that during class, we will use the breakout rooms where student teams can work separated from the class to do a group activity.
2. During your work in teams outside the class time, please discuss among yourselves the possibility of recording your own team session. Be sure every member agrees and is aware a recording maybe take place. Recordings can be a potent tool allowing team members to review what was discussed, to be sure the goals of the team will be achieved. Please be considerate and consider any recording as confidential among your team members. You can use this feature to practice your presentations, review them and identify opportunities for improvement.
3. Get familiar with the zoom annotation system, which is very useful to communicate with a presenter.
4. Get familiar with the "share screen" options. The share screen option has interesting options, such as sharing the window of a given application or the complete screen of your computer. The former may be more practical to avoid your audience to see notifications such as email and instant messaging that maybe you'd prefer to keep private. You could share a PowerPoint window, a browser if you plan to use content accessible through a webpage, etc.
5. As noted below in the "Media and Recording in Learning Environments" section, the Instructor may record your presentation for assessment purposes. In the measure of possible, please consider authorizing to share the recording with the rest of the class. This sharing can help your peers to consult the material after the class. However, there will not be any penalty in any means if a team decides not to share their recorded presentation to the rest of the class. We want to be clear that the confidentiality of our students is of the highest importance. If you decide to make available your recording, we will always share it with the rest of the class via password-protected access (D2L+YuJa).

Please be aware that the material such as Powerpoint slides used during your presentation may be requested so your peers can use that for review.

Guidelines for Zoom Sessions

Zoom is a video conferencing program that will allow us to meet at specific times for a 'live' video conference, so that we can have the opportunity to meet each other virtually and discuss relevant course topics as a learning community.

To help ensure Zoom sessions are private, do not share the Zoom link or password with others, or on any social media platforms. Zoom links and passwords are only intended for students registered in the course. Zoom recordings and materials presented in Zoom, including any teaching materials, must not be shared, distributed or published without the instructor's permission.

The use of video conferencing programs relies on participants to act ethically, honestly and with integrity; and in accordance with the principles of fairness, good faith, and respect (as the Code of Conduct). When entering Zoom or other video conferencing sessions, you play a role in helping create an effective, safe and respectful learning environment. Please be mindful of how your behaviour in these sessions may affect others. Participants are required to use names officially associated with their UCID (legal or preferred names listed in the Student Centre) when engaging in these activities. Instructors/moderators can remove those whose names do not appear on class rosters. Non-compliance may be investigated under relevant University of Calgary conduct policies. If participants have difficulties complying with this requirement, they should email the instructor of the class explaining why, so the instructor may consider whether to grant an exception, and on what terms. For more information on how to get the most out of your zoom sessions visit: https://elearn.ucalgary.ca/guidelines-for-zoom/.

If you are unable to attend a Zoom session, please contact your instructor to arrange an alternative activity (where available). Please be prepared, as best as you are able, to join class in a quiet space that will allow you to be fully present and engaged in Zoom sessions. Students will be advised by their instructor when they are expected to turn on their webcam (such as for group work, presentations, etc).

The instructor may record online Zoom class sessions for the purposes of supporting student learning in this class – such as making the recording available for review of the session or for students who miss a session. Students will be advised before the instructor initiates a recording of a Zoom session. These recordings will be used to support student learning only.

Conduct During Lectures

The classroom should be respected as a safe place to share ideas without judgement - a community in which we can all learn from one another. Students are expected to frame their comments and questions to lecturers in respectful and appropriate language, always maintaining sensitivity towards the topic. Students, employees,

and academic staff are also expected to demonstrate behaviour in class that promotes and maintains a positive and productive learning environment.

As members of the University community, students, employees and academic staff are expected to demonstrate conduct that is consistent with the University of Calgary Calendar, the Code of Conduct and Non-Academic Misconduct policy and procedures, which can be found at https://www.ucalgary.ca/policies/forms/title.

INTERNET AND ELECTRONIC COMMUNICATION DEVICE INFORMATION

Cell phones must be turned off in class unless otherwise arranged with the Instructor.

The use of laptop/home computers is required, given the nature of the online modality of the course. Nevertheless, please use them in a compatible manner to the course and classroom activities. Students should from accessing websites that may be distracting (e.g. personal emails, Facebook, YouTube). If on-campus installations, 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

The purpose of academic accommodation is to provide students with documented disabilities opportunities to access post-secondary education. Students with disabilities at the University of Calgary have met all admission requirements but may have done so with the use of accommodations. Similarly, they are expected to meet all academic and non-academic requirements. Adaptive technology and other academic accommodations do not relieve students of their responsibility to develop the essential skills and abilities expected of all students. The nature and type of academic accommodations vary from student to student and are dependent upon the student's disability and the academic requirements.

The Instructor will be pleased to discuss details for accommodations in tandem with the University representatives to ensure the student experience is optimal.

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

COPYRIGHT

It is the responsibility of students and professors to ensure that materials they post or distribute to others comply with the Copyright Act and the University's Fair Dealing Guidance for Students (library.ucalgary.ca/files/library/guidance_for_students.pdf). Further information for students is available on the Copyright Office web page (https://library.ucalgary.ca/copyright)

A NOTE REGARDING INSTRUCTOR INTELLECTUAL PROPERTY

Generally speaking, 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

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.