Subject Description Form

Subject Code	HTI5003
Subject Title	Medical Imaging Physics
Credit Value	3
Level	5
Pre-requisite / Co-requisite/ Exclusion	Nil This subject assumes some familiarity with fundamental principles of physics and basic knowledge of medical imaging. It is recommended to take 'Introduction to Physics' or equivalent subject in undergraduate study.
Objectives	This subject aims to deliver in-depth physical principles and state-of-the-art technologies of different medical imaging modalities spanning from conventional radiological imaging to evolving preclinical imaging modalities. The contents include mathematics and computation of medical imaging, underlying physics concepts and clinical applications of X-ray planar radiography, computed tomography, nuclear medicine imaging, magnetic resonance imaging, ultrasound imaging, and emerging molecular and hybrid imaging modalities. It is intended to be useful for post-graduate students and medical professionals including medical physicist seeking to expand or refresh their knowledge in the areas of medical imaging physics.
Intended Learning Outcomes (ILOs)	Upon completion of the subject, students will be able to: 1. Demonstrate in-depth understanding of mathematical models and image reconstruction mathematics, X-ray related physical phenomena, key electromagnetic physics for MRI, radioactive decay phenomena, and acoustic wave physics 2. Acquire advanced levels of knowledge for underlying working principles and state-of-the-art instrumentation technologies of X-ray planar radiography, computed tomography, nuclear medicine imaging, magnetic resonance imaging, and ultrasound imaging 3. Recognize advantages and limitations of each medical imaging modality for different clinical applications based on fundamental imaging principle and image quality 4. Apply different medical imaging modalities for diagnosis and therapeutic monitoring of representative diseases 5. Discuss the pros and cons of emerging molecular imaging, optical imaging, and hybrid imaging modalities to contribute to advances in clinical practices
Subject Synopsis/ Indicative Syllabus	**1. Overview of Medical Imaging** 1) Overview and history of medical imaging 2) Mathematics and computation for medical imaging **2. X-ray Planar Radiography** 1) Physics, production, properties, and interaction of X-rays 2) Instrumentation of X-ray tube, circuits, and accessories 3) Digital radiography, computed radiography, mammography, fluoroscopy **3. Computed Tomography** 1) Principles of CT data acquisition and image reconstruction 2) CT image quality and different types of CT instrument 3) Clinical applications of CT **4. Nuclear Medicine Imaging** 1) Principles and instrumentations of planar scintigraphy, SPECT, PET, and PET/MRI 2) Mechanism of radiopharmaceuticals and clinical applications of nuclear medicine

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5. Magnetic Resonance Imaging

1) MRI physics, MRI image sequences and instrumentation

2) Advanced MRI modalities: MR angiography, MR spectroscopy, fMRI, etc.

6. Ultrasound Imaging

1) Acoustic wave physics and instrumentation of Ultrasound imaging

2) Doppler ultrasound and elasticity imaging, clinical applications

7. Evolving Imaging Modalities

1) Molecular imaging, optical imaging, and hybrid imaging; endoscopy, laparoscopy, optical coherence tomography, near-infrared imaging, photo-acoustic imaging, Cerenkov imaging, terahertz imaging

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<tr><td>Teaching/Learning Methodology</td><td>

Face to Face Lectures: A series of lectures will be conducted to deliver comprehensive and integrative overview of subject contents including physical principles, state-of-the-art technologies, and clinical practices of different medical imaging modalities.

Practical Session: A practical session will provide interactive learning environment to enhance critical thinking and analytic ability of students related to quality control of X-ray planar radiography system.

Field Study: A field study will be performed in the hospital nuclear medicine and PET centre for students' active and practical learning related with cutting edge PET/CT and PET/MRI.

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<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>

<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="5">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>1. Practical Report</td><td>15 %</td><td>√</td><td>√</td><td>√</td><td></td><td></td></tr>
<tr><td>2. Field Study Report</td><td>10 %</td><td>√</td><td>√</td><td>√</td><td>√</td><td></td></tr>
<tr><td>3. Written Test
Test 1
Test 2</td><td>75 %
35%
40%</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="5"></td></tr>
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Practical Report: Students are required to submit a practical report (1000 words) after practical session on quality control of X-ray planar radiography system. The report is to evaluate students' independent learning capability, critical thinking, and analytic skills to analyze experimental data.

Field Study Report: Students are required to submit a practical worksheet by completing the answers to the provided questions after field study. The worksheet is to evaluate students' on-site learning and active participation.

Written Test: Two written tests (Mid-term test and Final test) will be performed to assess students' integration and application of the core knowledge and concepts in the physical principles, instrumentation technologies, and clinical diagnosis and treatment monitoring of modern medical imaging modalities.

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<tr><td>Student Study Effort Expected</td><td>

<table>
<tr><td>Class contacts:</td><td>(39 Hrs)</td></tr>
<tr><td>Lecture</td><td>34 Hrs.</td></tr>
<tr><td>Practical</td><td>3 Hrs.</td></tr>
<tr><td>Field Study</td><td>2 Hrs.</td></tr>
<tr><td>Self-study:</td><td>(81 Hrs)</td></tr>
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	Reading, assignments (3-4 hours for each class contact hour)	81 Hrs.
	Total	120 Hrs.
Reading List and References	Jerrold T. Bushberg, J. Anthony Seibert et al. *The Essential Physics of Medical Imaging*. LWW; Third, North American Edition (December 28, 2011) Nadine Barrie Smith, Andrew Webb. *Introduction to Medical Imaging: Physics, Engineering and Clinical Applications*. Cambridge University Press; Frist Edition (December 15, 2010) Ehsan Samei, Donald J. Peck. *Hendee's Physics of Medical Imaging*. Wiley-Blackwell; Fifth Edition (April 23, 2019) Paul Suetens. *Fundamentals of Medical Imaging*. Cambridge University Press; Third Edition (July 10, 2017) Anthony B. Wolbarst, Patrizio Capasso et al. *Medical Imaging: Essentials for Physicians*. Wiley-Blackwell; First Edition (June 4, 2013)	