Subject Description Form

Subject Code	**BSE2217**
Subject Title	**Heat and Mass Transfer**
Credit Value	3
Level	2
Pre-requisite Co-requisite Exclusion	BSE2216 Engineering Thermodynamics Nil Nil
Objectives	This subject is intended for students to learn the fundamentals of heat and mass transfer and their applications in buildings and in building services systems, in preparation for their further study of related engineering subjects in the BSE curriculum.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) understand the basic theories of heat and mass transfer and their significances in a wide range of engineering applications, especially in building energy and environment; b) analyse and evaluate thermal and mass transfer problems involving conduction, convection, radiation and diffusion; and c) understand the fundamentals of advanced numerical simulation of building performances involving heat and mass transfer processes.
Subject Synopsis/ Indicative Syllabus	**Fundamentals of heat transfer**: nature of heat transfer processes. Modes of heat transfer. **Conduction**: temperature gradient. Fourier's law of heat conduction. The law of conservation of energy. Steady state conduction in/across a slab, cylindrical shell. Electrical analogy to heat transfer. Thermal diffusivity and unsteady heat conduction. Transient conduction in an infinite slab. Introduction of numerical methods in heat transfer. **Convection**: Newton's law of cooling, and surface convective heat transfer coefficients. The concept of boundary layers. Transportation in turbulent flows. Temperature profile. Use of dimensionless parameters in convective heat transfer (Nu, Re, Pr, etc.). Forced convection along flat plate, inside pipes, around tube bundles. Heat transfer by free convection. **Radiation**: basic concepts. Absorption and emission at solid surfaces. Planck's radiation law. Stefan-Boltzmann law. Geometrical problems and configuration factor. Radiation between black bodies and non-black bodies at different temperatures. **Heat exchangers**: types of heat exchangers. Fouling factors. Parallel flow and counter flow arrangement. Mean and log mean temperature difference. Effectiveness and number of transfer units. Use of charts for complex flow patterns. Mass Transfer: Physical mechanisms of diffusion and convection; Fick's law; Analogy between mass and heat transfer; surface partition coefficient; Henry's Constant H; simultaneous mass and heat transfer mechanisms of evaporation **Heat and Mass transfer in the built environment**: combined effects of conduction, convection, and radiation heat transfer processes in buildings. **Related laboratory work** Operating characteristics of concentric tube heat exchanger (H5) Investigation of free and forced convection heat transfer. (H1)
Teaching/Learning Methodology	There will be 11 lectures to illustrate the fundamental principles, demonstrate the application of the theory with real-life problems, and explain the relevance to the professional jobs. There will be 9 tutorial sessions in half of the class size, during which students are expected to work on solutions of real-life problems via discussion with lecture and among themselves. Students will be required to do assigned-readings, particularly on the fundamentals, before attending lecturers and tutorials. The assigned readings will be detailed in the teaching scheme to be distributed to students at the beginning of the Semester.

In additions there are two laboratory sessions for students of a group of ~4, undertaking a prescribed set of measurements, analyzing the correlations, check against the theories learnt in the class.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)					
		a	b	c			
In class test	20	✓	✓				
Lab experiments and report	20	✓	✓	✓			
End-of-semester examination	60	✓	✓	✓			
Total	100%						

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

a) Building Services Engineers are expected to undertake on-site measurements, sophisticated quantitative analysis and design calculations, for problem identification and design optimization purposes.

b) The written test and exam serve to examine the students' learning outcome in the problem analysis and solving capabilities.

c) The lab sessions prepare the students for site measurements and data acquisition capabilities.

Student Study Effort Expected

Class contact:	
▪ Lectures	22 Hrs.
▪ Tutorials	9 Hrs.
▪ In class written test	2 Hrs.
▪ Laboratory (In groups of 4 students)	6 Hrs.
Other student study effort:	
▪ Reading and working on given exercises	69 Hrs.
▪ Lab Preparation and Report	6 Hrs.
Total student study effort	104 Hrs.

Reading List and References

TEXTBOOK

Yunus A. Cengel & Asshin J. Ghajar, Heat and Mass Transfer – Fundamentals and Applications, 5th Edition in SI units, McGraw Hill, 2015

OTHER REFERENCE BOOKS

Incropera FP, DeWitt DP, Bergman TL, Lavine AS, Fundamentals of heat and mass transfer, NY: John Wiley & Sons, 2007.

Douglas JF, Gasiorek JM, Swaffield JA, Fluid mechanics. NJ: Prentice Hall, 2001.