

SMA Handbook 2006/2007



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The information in this handbook is correct at the time of publication. However, SMA reserves the right to make changes when necessary and without prior notice.

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1. SMA's Commitment

The Singapore-MIT Alliance (SMA) is a global partnership between Massachusetts Institute of Technology (MIT), National University of Singapore (NUS) and Nanyang Technological University (NTU).

Founded in November 1998 to promote global graduate science & engineering education and research, SMA is the world's largest interactive distance education initiative. The partnership taps world-class engineering expertise, ideas and technology required for cutting-edge research to fuel Singapore as well as the region's growth as an innovation and education hub.

Please visit the SMA website at <http://www.sma.nus.edu.sg> for more details.

2. Key Contact Information

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3. Programmes and Candidature

The Alliance offers dual degrees which are awarded by both MIT and either NUS or NTU, as well as direct PhD degrees. The direct PhD degree will be awarded by either NUS or NTU depending on the university the Thesis Advisor is attached to.

SMA offers five programmes; four in the engineering disciplines and one in the life science discipline:

- Advanced Materials in Micro- and Nano-Systems (AMM&NS)
- Computational Engineering (CE)
- Chemical and Pharmaceutical Engineering (CPE)
- Manufacturing Systems and Technology (MST)
- Computation and Systems Biology (CSB)

Four of these programmes (AMM&NS, CE, CPE and MST) offer the following degree tracks:

- An MIT Masters AND an NUS/NTU Masters (Dual Masters)
- An MIT Masters and an NUS/NTU PhD (Masters-PhD)
- An NUS/NTU PhD degree with SMA certificate (Direct-entry PhD)

The CSB Programme offers an NUS/NTU PhD degree (Direct-entry PhD).

The expected period of candidature is as follows:

- Dual Masters track - 1.5 years
- Masters-PhD track - 5 years
- Direct PhD degree track - 4 years

The lectures and recitations will be delivered both through state-of-the-art interactive distance education technology and in a face-to-face class environment.

3.1 By Coursework

AMM&NS

The AMM&NS Programme offers the Dual Masters track where the *MIT Degree of Master of Engineering in Materials Science and Engineering* and the *NUS Degree of Master of Science (Advanced Materials for Micro- and Nano-Systems)* are awarded.

The AMM&NS Dual Masters track provides students with the background they need to become leaders in technology-based enterprises, especially those connected to advanced materials. The programme begins with graduate-level classes surveying the fundamentals of materials science and engineering with a focus on applying these fundamentals to real engineering problems and systems. This foundation is followed by subjects that build expertise in specific areas selected by the student and his or her advisor. Students are also encouraged to explore areas of interest outside the materials field, studying entrepreneurship or technology management for example. The programme's capstone experience involves student participation in engineering projects and technology assessment under the supervision of MIT faculty. Students spend the Fall term in residence at MIT, taking courses and exploring research opportunities with faculty. Students spend the Spring and Summer terms in residence in Singapore, where they continue to take distance-enabled MIT courses along with other MIT students still resident in Cambridge. Singapore-based students continue to collaborate with their MIT faculty supervisor and associated students and staff through regular video-conferencing as well as face-to-face meetings when MIT lecturers travel to Singapore.

The MIT Master of Engineering degree in Materials Science and Engineering requires students to take 5 core courses, 3 restricted elective and complete a thesis. The NUS Master of Science (AMM&NS) degree requires the student to take 4 core courses and 4 elective courses. In addition, a student must complete a project through a 6-month internship programme.

CE

The CE Programme offers the Dual Masters track where the *MIT Degree of Master of Science in Computation for Design and Optimization* and the *NUS Degree of Master of Science (Computational Engineering)* are awarded.

The CE Dual Masters track is a programme aimed at the education of students in the formulation, analysis, implementation, and critical application of computational approaches to understanding, predicting, optimizing, and designing engineered systems. The programme emphasizes breadth through introductory courses in the areas of numerical simulation, optimization, probability and statistics; depth in the areas of optimization methods and numerical methods for partial differential equations; integration and multidisciplinary aspects; hands-on experience through numerous exercises, projects and assignments; and the option of a significant thesis or two smaller separate thesis projects. A component of this degree is the 6-month internship. The degree programme will provide graduates with familiarity with state-of-the-art numerical tools as well as specialization in many of these tools.

The MIT Master of Science degree in Computation for Design and Optimization (CDO) requires students to take at least 3 out of 4 core courses, 1 or 2 restricted electives out of 16 MIT courses, 1 unrestricted elective and complete a thesis. The NUS Master of Science (CE) degree requires the student to take 4 core courses, 2 restricted electives out of 16 MIT courses and 1 elective from NUS. In addition, a student must complete a project through a 3-month internship programme.

CPE

The CPE Programme offers the Dual Masters track where the *MIT Degree of Master of Science in Chemical Engineering Practice* and the *NUS Degree of Master of Science (Chemical and Pharmaceutical Engineering)* are awarded.

The CPE Dual Masters track is a unique opportunity to get a Master's Degree in the MIT School of Chemical Engineering Practice. Established in 1916 to provide practical training in an industrial environment that would supplement classroom studies, the Practice School is the heart of MIT's Master of Science in Chemical Engineering Practice degree. In Practice School, students will reside at two host company stations. At each station students will work on projects with teams of their peers and will be supervised by a resident MIT staff member. These projects will be current, challenging assignments within the realm of the host company's line of business or research, and will be for their benefit, using their facilities, and in consultation with their technical staff. The students will have day-to-day interaction with company personnel and management teams, and will be called upon to communicate the process and results of the work both orally and in writing.

The MIT Master of Science in Chemical Engineering Practice degree requires students to take 5 compulsory modules, 1 compulsory elective and complete 16 weeks at Practice School working in teams to solve pressing technical problems in short periods of time. The NUS Master of Science in Chemical and Pharmaceutical Engineering degree requires the student to take 4 compulsory modules and 6 elective modules.

MST

The MST Programme offers the Dual Masters track where the *MIT Degree of Master of Engineering in Manufacturing* and the *NTU Degree of Master of Science (Manufacturing Systems and Technology)* are awarded.

The MST Dual Masters track combines a broad based approach with independent research and concentrate on problems of emerging industries. Students will combine industry-based project experience with a university-based research derived from that experience. The MIT degree will be taken partly in residence at MIT and by distance at NTU, and will be primarily coursework-based with a group project in industry supervised by MIT. The NTU degree will include coursework and independent research with NTU faculty supervision.

The MIT Masters of Engineering degree in Manufacturing requires students to take 8 core coursework courses and complete a thesis. The NTU Master of Science (MST) degree requires the student to take 4 core courses and 2 elective courses out of a choice of 12 courses and attend seminars on Emerging Manufacturing Industries. In addition, a student must complete a research project through independent exploration and study in a 6-month internship programme.

3.2 By Research

AMM&NS

The AMM&NS Programme offers the following graduate degrees by research:

- The Masters-PhD track where the *MIT Degree of Master of Engineering in Materials Science and Engineering* and the *NUS/NTU Doctor of Philosophy (Advanced Materials for Micro- and Nano-Systems)* are awarded.
- *Doctor of Philosophy (Advanced Materials for Micro- and Nano-Systems)*

The complementary professional Masters-PhD degree track trains students to apply their knowledge of advanced materials to industrial challenges, focusing primarily in the area of microelectronics and emerging nanotechnologies. The S.M. degree also builds on NUS and MIT coursework and faculty mentoring from all three university partners, to include a semester-long industry, research institute, or university-based research project in Singapore. This provides an opportunity to apply the student's new understanding of the principles of materials engineering and technology assessment in research or engineering-based enterprises.

The MIT Master of Engineering degree in Materials Science and Engineering requires students to take 5 core courses, 3 restricted elective and complete a thesis. The PhD degree provides training in a particular area of specialization and the students must pass the PhD QE. The coursework courses consist of 7 core courses, 3 thesis-related electives and 2 breadth-courses.

The direct-entry PhD track prepares students for advanced careers in industrial research and development centres, as well as research institutes or academic departments involved in cutting-edge research with a focus on applications in micro- and nano-systems. The coursework requirement for the PhD degree includes 7 core courses, 3 thesis-related electives and 2 breadth-courses from a selection outside of the Materials area. Thesis research is co-supervised by faculty from Singapore and MIT, and in many cases, is carried out in collaboration with researchers in Singapore's research institutes. Thesis research topics range from problems in fundamental materials physics to development of new nano-scale devices.

CE

The CE Programme offers the following graduate degree by research:

- The Masters-PhD track where the *MIT Degree of Master of Science in Computation for Design and Optimization* and the *NUS/NTU Doctor of Philosophy (Computational Engineering)* are awarded.
- *Doctor of Philosophy (Computational Engineering)*

The Masters-PhD degree track includes essentially the same coursework as the Dual Masters programme but additionally involves specialization courses and a significant research component emphasizing the formulation, analysis and implementation of new computational methods for the simulation and optimization of problems of emerging practical and strategic interest. The MIT Master of Science degree in Computation for Design and Optimization (CDO) requires students to take at least 3 out of 4 compulsory courses, 1 or 2 restricted electives out of 16 MIT courses, 1 unrestricted elective and complete a thesis. PhD students in this track must pass the PhD QE. The coursework courses consist of 4 core courses and 2 restricted electives out of 16 MIT courses and 1 elective from NUS. In addition, they need to read 2 breadth-courses.

The intended audiences for the direct-entry PhD track are scientists and engineers who wish to further develop their skills in the rapidly evolving field of numerical simulation, modeling, design, and optimization. It is expected that students will have a strong foundation in a core disciplinary area such as engineering, materials science, physics, biology, or mathematics. The coursework requirement for these PhD students includes 4 core courses, 3 restricted electives and 2 breadth-courses.

CPE

The CPE Programme offers the following graduate degree by research:

- The Masters-PhD track where the *MIT Degree of Master of Science in Chemical Engineering Practice* and the *NUS/NTU Doctor of Philosophy (Chemical and Pharmaceutical Engineering)* are awarded.
- *Doctor of Philosophy (Chemical and Pharmaceutical Engineering)*

This is a research doctorate degree programme with an emphasis on synthesis skills, engineering design, and interdisciplinary approaches focused on chemicals and pharmaceuticals. The training includes communication, problem solving, and participating in cutting edge research and technology with a focus on entrepreneurship and innovation. The Doctoral degree conferred by NUS/NTU prepares

graduates for dynamic careers in industrial research and development centres, research institutes, or academic departments interested in molecular engineering, and chemical engineering processes. Research will be carried out in the laboratories of the SMA Fellows at NUS-NTU, as well as collaborating Research Institutes in Singapore. All projects will be co-supervised by one Singapore Faculty and by one MIT Faculty. The doctoral thesis will be submitted to, evaluated and accepted by the NUS Faculty and Thesis Committee, that also includes MIT Faculty.

The Masters-PhD degree track includes essentially the same coursework as the Dual Masters programme except that the PhD degree provides training in a particular area of specialization and the students must pursue coursework modules which consist of 4 compulsory modules and 2 thesis-related electives.

MST

The MST Programme offers the following graduate degree by research:

- The Masters-PhD track where the *MIT Degree of Master of Engineering in Manufacturing* and the *NUS/NTU Doctor of Philosophy (Manufacturing Systems and Technology)* are awarded.
- *Doctor of Philosophy (Manufacturing Systems and Technology)*

The Masters-PhD degree track includes essentially the same coursework as the Dual Masters programme but additionally involves specialization courses and a significant research component emphasizing critical technological roadblocks brought about by working at the micron and sub-micron-level length scale and on this new class of products.

The MIT Masters of Engineering degree in Manufacturing requires students to take 8 core courses and complete a thesis. The PhD degree provides training in a particular area of specialization and the students must pursue coursework courses which comprise 4 core courses and 2 electives as well as attend seminars on Emerging Manufacturing Industries and undertake practical work.

Students in the direct PhD track will be part of a concentrated research effort to address the critical technological roadblocks brought about by working at the micron and sub-micron-level length scale and on this new class of products. PhD students will have a primary supervisor at NTU or NUS with formal participation by MIT faculty. The coursework requirements for these PhD students are 4 core courses and 2 thesis-related electives.

CSB

The CSB Programme offers the following graduate degree by research:

- *Doctor of Philosophy (Computation and Systems Biology)*

A direct PhD programme only, CSB students must demonstrate a working familiarity with molecular and cell biology, biochemistry or genetics, mathematics (differential equations), and physics or physical chemistry. An ideal candidate will have majored in engineering with a strong biology/bioengineering track or in biology with a strong background in engineering, physics, mathematics or computer science.

For successful completion of the program, students must complete the CSB/SMA curriculum, pass a written qualifying exam after their first year, satisfy a six-month residence requirement, and successfully defend a research thesis. The projects will be conducted on problems identified within the Inter University and Flagship research programmes and be jointly supervised by an MIT and Singapore mentor.

The CSB PhD curriculum draws from courses in the CSB PhD programme as well as elective courses at MIT, NUS, and NTU. Students will take three core courses for a foundation in systems and computational biology and three elective courses that expand the breadth and extend the depth of study. The core and elective courses will be offered at MIT, NUS, NTU and BII either as long-distance or residence courses. Students are expected to complete most of their coursework in the first two years. Courses co-taught by MIT and Singapore faculty are long-distance offerings.

Research Degrees

Each programme will determine the set of courses that a candidate must complete for the award of a research degree before taking the PhD Qualifying Examination (QE). The QE will comprise an oral and/or written component depending on the programme.

Each programme includes graduate-level foundation coursework and prepares the student for research. The recommended coursework component comprises between 6 to 12 courses. The student must pass all the relevant examinations. Students will be permitted to read courses from other SMA programmes, provided the fellows teaching the course give their approval

PhD students in the second phase of SMA programmes will be required to take the Graduate Seminar Courses where they present their current research to faculty members, graduate students and visitors. This would form part of their coursework requirement.

All direct-entry PhD students, upon successful completion of all the PhD degree requirements, would be awarded an NUS/NTU PhD degree with an SMA certificate.

4. Programme Requirements

4.1 Admission Requirements

Candidates for SMA programmes are enrolled at the beginning of July each year on a full-time basis only. For the dual degree Successful applicants must satisfy the admission and degree requirements at each of the co-hosting Alliance Universities, as defined and approved for each programme by each co-hosting Alliance University and its faculties in accordance with their applicable policies, procedures and standards.

To qualify for admission to all SMA programmes hosted by either NUS or NTU, a student must have earned a good Bachelors degree and/or Masters degree in the fields of Engineering, Science or Computer Science with a 1st or 2nd Upper Class Honours degree or its equivalent from a university of acceptable standing.

For admission as a PhD candidate, the candidate must submit evidence of adequate training and ability to undertake the proposed course of study. The student must first be admitted to the Singapore university which hosts the programme and subsequently re-register (if applicable) with the university to which his or her main Thesis Advisor is affiliated.

Submission of Graduate Record Examination (GRE) is required for all applicants while submission of Test of English as a Foreign Language (TOEFL) is required for applicants whose native language is not English. A computer-based minimum TOEFL score of 233 is required. The following categories of applicants are exempted from the TOEFL requirement:

- a. received instruction in English in primary and secondary schools
- b. been in an English speaking country for four years or longer
- c. received degrees from America, British, Canadian, Australian or New Zealand universities
- d. received first degrees from NUS or NTU

4.2 Residency Requirements

MIT Residency Requirement

The MIT residency requirements of each dual degree programme is as follows:

<u>Programme</u>	<u>Duration of MIT Residency</u>	<u>Term During Candidature</u>
AMM&NS	4 months (Sep – Dec)	1 st Fall for all 3 degree tracks
CE	7 months (Feb – Aug)	1 st Spring & 2 nd Summer for dual degree tracks
MST	4 months (Sep – Dec)	1 st Fall for dual degree tracks
CPE	4 months (Sep – Dec)	1 st Fall for dual degree tracks

Dual Masters students spend one semester at MIT. The PhD students in the Masters-PhD spend up to a total of three semesters at MIT while the direct PhD students spend up to a total of two semesters at MIT. The CSB programme has a fixed schedule for the residency at MIT which is as follows:

CSB	5 months (Jan – June) & 1 month	1 st Spring & final year of candidature
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NUS/NTU Residency Requirement

Students must reside in Singapore in accordance with the period stipulated by each programme.

4.3 Continuation and Graduation Requirements

For Degree conferred by NUS

Coursework-based Programmes

A student pursuing a Masters degree by coursework must achieve a minimum CAP of 3.0 to be eligible for graduation. A student may read more than the minimum necessary courses (comprising all required courses and at least 30 MCs at level 5000 or 6000 within the subject or related disciplines). Only the grades for the minimum necessary courses shall be considered in assessing whether the student has met the degree requirement.

A student whose CAP falls below 2.5 for two semesters or 3.0 for three semesters will have his or her candidature terminated. These semesters, not necessarily consecutive, would be those during which courses read count towards either the NUS or NTU degree. However the computation of CAP would exclude those courses which are double-counted towards the MIT degree. The courses which are double-counted will be considered as transfer of credits. For any semester in which the student's CAP falls below 3.0, he or she will be issued a warning. If, in the next semester, his or her CAP again falls below 3.0, but above 2.5, he or she will be placed on probation.

Research-based Programmes

To be eligible for graduation, a student pursuing a Masters degree by research must achieve a minimum CAP of 3.0 for all required courses, and have passed the Masters thesis. Similarly, to obtain a PhD degree, the minimum CAP required for graduation is 3.5. In addition, the candidate must have passed the qualifying examination, the PhD thesis, and the oral examination.

To continue in a Masters programme, a student's CAP should not fall below 2.5 or equivalent for 2 semesters, or 3.0 for 3 semesters. A student pursuing a PhD programme must ensure that his or her CAP does not fall below 3.0 or equivalent for 2 semesters, or 3.5 for 3 semesters. These semesters, not necessarily consecutive, would be those during which courses read count towards either the NUS or NTU degree. Wherever applicable, the computation of CAP would exclude those courses which are double-counted towards the MIT degree. The courses which are double-counted will be considered as transfer of credits. Termination of candidature would result if a student fails to maintain the minimum CAP. For any semester in which the student's CAP falls below the CAP required for graduation, s/he will be issued a warning. If, in the next semester, the student's CAP again falls below the graduation requirement, but not sufficiently to warrant immediate termination, s/he will be placed on probation. A student may also be issued a warning or placed on probation for poor performance on the Qualifying Examination, research thesis, or other programme requirements.

For Degree conferred by NTU

Coursework-based Programmes

A student pursuing a Masters degree by coursework must achieve a minimum CGPA of 2.5 as well as successfully completed all requirements as prescribed by the programme of study to be eligible for graduation.

A student whose TGPA falls below 2.5 for two semesters will have his or her candidature terminated. These semesters, not necessarily consecutive, would be those during which courses read count towards either the NUS or NTU degree. However the computation of TGPA would exclude those courses which are double-counted towards the MIT degree. The courses which are double-counted will be considered as transfer of credits. For any semester in which the student's TGPA falls below 2.5 in any term of study, he or she will be issued a warning.

Research-based Programmes

To be eligible for graduation, a student pursuing a Masters degree by research must achieve a minimum CGPA of 3.0 for all required courses, and have successfully completed all the requirements as prescribed by the programme of study or School. Similarly, to obtain a PhD degree, the minimum CGPA required for graduation is 3.5. In addition, the candidate must have completed all subjects requirements.

To continue in a Masters programme, a student's TGPA should not fall below 3.0 in any semester of study and must attain at least grade point 2.5 (grade C+) in every subject as well as complete all subject requirements within the stipulated period. A student pursuing a PhD programme must ensure that his or her TGPA does not fall below 3.5 in any semester of study and must attain at least grade point 2.5 (grade C+) in every subject as well as complete all subject requirements within the stipulated period. These semesters, not necessarily consecutive, would be those during which courses read count towards either the NUS or NTU degree. Wherever applicable, the computation of CAP would exclude those courses which are double-counted towards the MIT degree. The courses which are double-counted will be considered as transfer of credits. Termination of candidature/financial aid would result if a student fails to maintain a TGPA of above 2.5 in two semesters or 3.0 in three semesters as well as failure to complete all subject requirements within the stipulated period.

4.4 Holiday Leave

Masters students are given a holiday leave entitlement of 10 days per academic year while the PhD students have 21 days of holiday leave per calendar year. Any leave taken in excess of the entitlement will be treated as unpaid leave and the monthly stipend and allowances will be deducted accordingly.

4.5 Assessment modes/Examination rules

Appeal

A student whose candidature has been terminated may appeal to the SMA Co-Directors for re-consideration.

Academic Honesty

Cheating, plagiarism, unauthorised collaboration and other forms of academic dishonesty are considered serious offences for which disciplinary penalties would be imposed.

Some academic offences by students can be handled directly between the Subject Co-ordinator and the students involved. In some cases, it may be necessary for the Programme Co-Chair to review, or otherwise to assist in, the resolution of the matter. When a dispute cannot be resolved satisfactorily within the programme, or if it seems appropriate, a complaint against a student can be brought to the attention of the Deputy Director/Co-Director who is the final authority for academic conduct. Based on the decision of the Deputy Director/Co-Director, the student will be informed of the penalty to be imposed. This could include not taking into account the marks and grades for that particular assignment/quiz/examination.

Excused Absences from Quizzes/Examinations

A student may be excused from scheduled quizzes/examinations for reasons of illness. In the event a student falls ill on the scheduled date of quizzes/examinations, the student should contact the SMA Office which will then inform the Subject Co-ordinator and the

Programme Co-Chair. The student then needs to submit the Medical Certificate together with the University's prescribed form certified by the medical doctor.

The Subject Co-ordinator, in consultation with the Course Co-ordinator and Programme Co-Chair, will review the case and if they make a decision not to take into account the particular component when collating the final marks and grades for that particular assignment/quiz/examination, they must be prepared to submit a final mark and grade based on other evidence.

5. SMA Graduate Fellowship

A dual Masters or Masters-PhD student is a student of both MIT and NUS or NTU. The student must first be separately and independently admitted by MIT and by NUS or NTU to their respective universities' programmes and only then will the student be eligible for an SMA Graduate Fellowship. Upon independent admission of the student by each co-hosting Alliance University and a separate subsequent decision by the SMA Graduate Fellowship Selection Committee to grant an SMA Graduate Fellowship, the student will become an SMA Graduate Fellow.

A direct-entry PhD student must first be admitted in the first instance by the Singapore University hosting the programme. Upon admission and the grant of an SMA Graduate Fellowship, the student will become an SMA Graduate Fellow.

The SMA Graduate Fellowship monthly stipend is S\$1500 for foreign students and S\$2000 for Singapore citizens and Singapore permanent residents. PhD students will receive an additional S\$500 per month upon passing the PhD Qualifying examination.

Additionally, a living allowance of US\$1000 per month, up to a maximum of US\$6000, will be given to the SMA Graduate Fellow during residency at MIT. The SMA Office will fund an economy-class round-trip airfare to MIT.

In relation to your residency at Singapore, you can expect to pay for the following:

- Registration fee of SGD 52.50 (NUS and NTU)
- Computer Account fee of SGD 10.50 (NUS) / SGD 13.65 (NTU) per annum
- Student Activity and Services fee of SGD 67.20 (NUS) per annum
- Amenities fee of SGD 12.60 (NTU) per annum
- Pre-enrolment medical examination expenses that range between SGD 25.00 to SGD 42.00
- Student Pass Application fee of SGD 40.00
- CLASS fee of SGD 13.00 (NUS) / SGD \$5.00 (NTU) per annum
- Student card fee of SGD 10.50 (NTU)
- Health and Insurance of SGD 112.75 (NUS) / SGD 69 (NTU) per annum

In relation to your residency at MIT, you can expect to pay for the following:

- Housing at Boston which can be either at MIT or off campus
- Medical check-up in Singapore prior to leaving for MIT
- Mandatory insurance in line with the US Federal requirements for J-1 visa holders
- SEVIS fee of USD100
- J-1 visa application fee of approximately SGD 170

The tuition fee imposed by the Singapore universities and MIT will be paid by the SMA Office.

Note: All cost indicated are subject to changes.

6. Course Listings

6.1 Graduate Seminar Courses

SMA6779 Doctoral Seminars

Modular credits: 4

Workload: NA-NA-NA-NA-NA

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

This course is for SMA PhD students and it requires students to 1) attend at least one technical parallel session during the SMA Annual Symposium and 2) present at least 2 seminars on their research during their candidature, excluding the qualifying examination oral and final oral defence but including the SMA Annual Symposium. For each seminar presentation, the abstract, presentation materials (such as Powerpoint file), etc are to be printed and submitted to the SMA Office. Grading is on S/U on the basis of attendance, participation and presentation.

6.2 Advanced Materials in Micro- and Nano-Systems (AMM&NS)

SMA5120 Fundamentals of Semiconductor Device Physics

Modular credits: 4

Workload: 3-1-NA-NA-6

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

This course will help in providing strong foundation in the area of Semiconductor Devices and Physics. Drift and diffusion of carriers. Generation and recombination. Current continuity equations in semiconductors. Forward and reverse-biased p-n junctions. Current injection. Zener and avalanche breakdown. Ideal and non-ideal metal-oxide-semiconductor capacitors. Structure and operation modelling of metal-oxide-semiconductor field effect transistors and bipolar junction transistors.

SMA5121 Yield, Reliability & Failure Analysis of Microsystems

Modular credits: 4

Workload: 3-1-NA-NA-6

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

This course provides an understanding in the yield, reliability and failure mechanisms of microsystems. Students would be able to design test plans to determine reliability, for accelerated stress testing, failure analysis and materials analysis of microsystems. Topics include: Overview of yield, reliability and failure mechanisms in Microsystems. Mechanisms of integrated circuit yield loss. Modeling of yield loss mechanisms. Mathematics of failure distributions, reliability and failure rates. Reliability assessment strategies, accelerated stress testing and burn-in screen. Failure analysis methodology. Fault localization and failure identification. Failure mechanisms. Failure analysis tools and techniques. Interconnect reliability. CMOS latchup. Gate oxide and hot-carrier reliability. Packaging-related reliability. Reliability case study on photonics, MEMS and/or BioMEMS Microsystems.

SMA5122 Compound Semiconductors and Devices

Modular credits: 4

Workload: 3-1-NA-1-7

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

This course introduces the physics, modeling, application, and technology of compound semiconductors (primarily the III-Vs) in electronic, optoelectronic, and photonic devices and integrated circuits. The distinguishing feature of compound semiconductors is the wide variety of materials that can be used to form heterostructures with unique electrical and optical properties. The course introduces material concepts such as strain and bandgap engineering and how they can be utilised to advantage for enhancing the performance of devices. Topics include: properties, preparation, and processing of compound semiconductors; theory and practice of heterojunctions, quantum structures, and pseudomorphic strained layers; metal-semiconductor field effect transistors (MESFETs); heterojunction field effect transistors (HSFETs) and bipolar transistors (HBTs); optoelectronic devices including light emitting diodes, laser diodes, and photodetectors.

SMA5199 Internship Project

Modular credits: 12

Workload: NA-NA-NA-15-20-NA (Total workload: Min of 390 hours over a period of 6 months)

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

This course provides the opportunity for the student to develop his/her independent research capability by conducting an investigation in a topic under the guidance of supervisor(s). Each student is to research independently on an approved topic under the guidance of Supervisor(s). A Thesis is to be submitted at the end of this course. The work may relate to the following areas: feasibility studies, design work, materials & device characterisation, failure analysis, process course development, stimulation & modelling.

3.205 Thermodynamics and Kinetics of Materials

Modular credits: 4

Workload: 4-NA-NA-NA-8

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

An MIT subject which provide an understanding in both the thermodynamics and kinetics aspects at the end of the course. The thermodynamics aspect includes laws of thermodynamics, solution theory and equilibrium diagrams. The kinetics aspect includes diffusion, phase transformations, and the development of microstructure. Topics include: Entropy and free energy; Energies of defects; Diffusion-mechanisms; Transition state theory and field effects; Solution theory; Phase diagrams; Nucleation in condensed phases; Interfaces; Crystal growth – atomistics, dendritic growth, solute redistribution and cellular growth; Phase transformation theories; Coarsening; Spinodal decomposition.

3.225 Electronic and Mechanical Properties of Materials

Modular credits: 4

Workload: 4-NA-NA-NA-8

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

An MIT subject which allows students to learn the roles of bonding, structure (crystalline, defect, energy band, and microstructure), and composition in influencing and controlling physical properties from case studies drawn from a variety of applications including semiconductor diodes, optical detectors, sensors, thin films, biomaterials, composites, and cellular materials. Topics include: Hydrodynamic representation of electrons; Origins of Ohms law; Hall effect; Electron energy bands; Electron waves; Effective mass; Origin of mechanical properties; Basic mechanics concepts; Stress at a point; General tensors; Microscopic and macroscopic aspects of plasticity; Dislocations in structural materials and thin films; Basics of viscoelasticity and creep; Fracture mechanics and micromechanisms; Fatigue damage and failure; Mechanical and electrical properties of semiconductors; Dielectric and optical properties; Coupled electrical/mechanical behaviour and piezoelectricity; Microscopic origin of magnetization; Exchange and ferromagnetism.

3.320 Atomistic Computer Modeling of Materials

Modular credits: 4

Workload: 3-NA-NA-NA-9

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

This MIT subject allows students to understand the theory and application of atomistic computer simulations to model, understand, and predict the properties of real materials. Topics to be covered in this course are: Deterministic and stochastic methods. Monte Carlo and molecular dynamics. Energy models (classical and quantum-mechanical). Free energy computation. Phase transformations. Metastability. Order-disorder transformations. Defect properties. Transport properties. Emphasis on solving relevant problems in a variety of materials classes.

3.44 Electronic Materials and Thin Film Processing

Modular credits: 4

Workload: 3-NA-NA-NA-9

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

An MIT subject for students to gain a strong understanding in Electronic Materials and Thin Film Processing from the use of examples on materials processing for applications in high-performance integrated circuits as well as in micromagnetic, microelectromechanical, and photonic devices. Topics covered in this course are: Materials science and engineering of microfabrication processes for ICs and MEMS. Crystal growth and epitaxy. Diffusion and ion implantation. Thin film reactions, including oxidation and silicidation. Control of structure and property evolution in polycrystalline films. Surface and bulk micromachining. Kinetic phenomena leading to self-organisation. Use of process simulators.

3.48J Materials & Processes for MEMS

Modular credits: 4

Workload: 3-NA-NA-NA-9

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

This MIT subject presents a unified treatment of the key principles in materials and processing for the design and manufacture of microelectromechanical systems (MEMS). Emphasis on materials and processes commonly used for fabrication for MEMS and not microelectronic systems. Includes discussion of the processing and properties of both thin and thick film bonding, bulk micromachining techniques, and the relationships between processing and properties of active materials such as piezoelectrics, ferroelectrics and phase-transition materials. Key material properties and parameters and their relationships with microfabrication processes and applications are discussed, including elastic and inelastic deformation, fracture, residual stress, fatigue, creep, adhesion, stiction, and coupled-field constitutive behaviour. Materials and process selection and case studies of applications provide a unifying theme.

3.57J Materials Selection, Design and Economics

Modular credits: 4

Workload: 3-NA-NA-NA-7

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

An MIT subject which allows students to learn how to use analytical techniques to develop a plan for starting a new materials-related business. Theory and application of systems analysis techniques and engineering principles for identifying optimal materials, designs and processes for specific applications. Topics include production functions, cost modelling, mathematical optimisation, materials selection algorithms, property charts and performance indices, materials demand modeling.

6.3 Computational Engineering (CE)

SMA5230 Linear Algebra

Modular credits: 4

Workload: 3-1-NA-3-3

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

A basic subject on matrix theory and linear algebra, emphasizing topics useful in other disciplines, including systems of equations, vector spaces, determinants, eigenvalues, similarity, and positive definite matrices. Applications to least-squares approximations, stability of differential equations, and others.

SMA5231 Computing Technology and Tools

Modular credits: 4

Workload: 8-NA-6-2-4

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

This hands-on course gives students from various backgrounds in computing and programming an equal start. Various aspects of computing technology and tools will be covered: such as an introduction to Linux operating system, common software packages, programming methodology, data structure, and algorithmic complexity. The course will cover Mathematica and matlab in some details. It will spend more than half of time on C and C++ programming. It will also give an introduction to Fortran.

SMA5232 Cluster And Grid Computing Technologies For Scientific Computing

Modular credits: 4

Workload: 3-NA-3-8-6

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

The course introduces basic concepts of parallel computing on clusters and the grid and their influence on numerical algorithms that are commonly used in the numerical modeling of large scale engineering simulation and optimization problems. Elements of MPI are covered to enable both cluster and grid implementation of numerical algorithms written in FORTRAN and C on parallel computers in an efficient

manner. The advantages and disadvantages of using a parallel programming paradigm like MPI for cluster and grid computing are discussed. Hands-on computational laboratory exercises on selected numerical algorithms and parallel numerical libraries are included to give insight into performance measures and the influence of computer architectures on the programming and performance of selected numerical algorithms.

SMA5233 Particle Methods and Molecular Dynamics

Modular credits: 4

Workload: 2-NA-4-4-4

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

This course provides an overview of the theory and algorithms that form the basis for molecular modeling at different levels of approximation. Review of Monte Carlo and molecular dynamics simulation techniques: molecular mechanics via empirical force field models. Energy minimization methods and conformational analysis. Quantum simulation techniques. Introduction to particle methods. Introduction to simulation software, e.g. Celcius 2, insight II, MOPAC, Application examples: structure phase transitions, surfaces, protein simulation, and drug design.

SMA5299 Internship Project

Modular credits: 12

Workload: NA-NA-NA-15-20-NA (Total workload: Min of 390 hours over a period of 6 months)

Pre-Requisite(s)/Preclusion(s)/Cross-listing(s): NA

This course provides the opportunity for the student to develop his/her independent research capability by conducting an investigation in a topic under the guidance of supervisor(s). Each student is to research independently on an approved topic under the guidance of Supervisor(s). A Thesis is to be submitted at the end of this course. The work may relate to the following areas: software product, production process, fast algorithm applications, engineered systems, optimisation applications, innovative IT.

6.336J Introduction to Numerical Simulation

Modular credits: 4

Workload: 3-1-NA-NA-6

Pre-Requisite(s)/Preclusion(s): NA

Cross-listings: 16.190J, 2.096J (MIT)

This MIT course is an introduction to computational techniques for the simulation of a large variety of engineering and engineered systems. Applications are drawn from aerospace, mechanical, electrical, and chemical engineering, as well as materials science and operations research. Topics include mathematical formulations; network problems; sparse direct and iterative matrix solution techniques; Newton iteration for nonlinear problems; solution techniques for eigenvalue problems; discretisation methods for ordinary differential equations and differential-algebraic equations; discretisation methods for partial differential and stochastic partial differential equations; methods for the solution of integral equations; and Monte Carlo techniques and higher dimensional problems.

15.093J Optimization Methods

Modular credits: 4

Workload: 3-1-NA-NA-6

Pre-Requisite(s)/Preclusion(s): NA

Cross-listing: 2.098J (MIT)

This MIT course is an introduction to the principal methods for linear, network, discrete, nonlinear optimisation, as well as dynamic optimisation and optimal control. Emphasis is on methodology and the underlying mathematical structures and their connection to computational procedures. On completing this course, one will be in a position to formulate interesting optimization problems in various application areas, judge whether these problems are tractably solvable, and be able to solve them using appropriate techniques.

16.920J Numerical Methods for Partial Differential Equations

Modular credits: 4

Workload: 3-1-NA-NA-6

Pre-Requisite(s)/Preclusion(s): NA

Cross-listing: 2.097J (MIT)

This MIT course covers the fundamentals of modern numerical techniques for a wide range of linear and nonlinear elliptic, parabolic, and hyperbolic partial differential and integral equations. Topics include: mathematical formulations; finite difference, finite volume, finite element, and boundary element discretisation methods; and direct and iterative solution techniques. The methodologies described form the foundation for computational approaches to engineering systems involving heat transfer, solid mechanics, fluid dynamics, and electromagnetics. Computer assignments requiring programming.

18.335J Introduction to Numerical Methods

Modular credits: 4

Workload: 3-NA-NA-NA-9

Pre-Requisite(s)/Preclusion(s): NA

Cross-listing: 6.337J (MIT)

This MIT course teaches students basic numerical computational methods. Topics include: IEEE-standard, iterative and direct linear system solution methods, eigendecomposition and model-order reduction, fast Fourier transforms, multigrid, wavelets and other multiresolution methods, matrix sparsification. Nonlinear root finding (Newton's method). Numerical interpolation and extrapolation. Quadrature. Ordinary differential equations.

6.4 Manufacturing Systems and Technology (MST)

SMA6320 Finite Element Method: Technique and Applications

Modular credits: 4

Workload: 2-1-3-3-11

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

The basic concepts for finite element method and the theoretical framework for the formulation of finite elements are discussed, which includes interpolation and shape functions, numerical integration, stiffness matrix, calculation of stresses and strains, and the application of boundary conditions etc. Various modelling techniques are presented and they are illustrated by case studies in a variety of disciplines. The limitations and traps of FEM are highlighted. Hand-on experience using a commercial FEM package is provided. Practical experience is gained through laboratory and project work.

SMA6328 Product Design and Development

Modular credits: 4

Workload: 3-NA-3-4-NA

Pre-Requisite(s)/Preclusion(s): NA

Cross-listing: 2.739J (MIT)

This course covers modern tools and methods for product design and development. The cornerstone of this subject is a project in which terms of management, engineering and industrial design students conceive, design, and prototype a physical product. Class sessions are conducted in workshop mode and employ cases and hands-on exercise to reinforce key ideas.

SMA6329 Professional Seminars in Emerging Manufacturing Industries

Modular credits: 2

Workload: 2-NA-NA-4-4

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

The course provides an integrative forum for manufacturing students. It focuses on the inter-relationship of major themes in entrepreneurship, leadership and markets and competition in the future. Covers a set of integrative manufacturing topics on emerging industries and technologies. A broad 'enterprise-wide' view of manufacturing will be provided. Students will hear from both the academic and business community about overall trends, new forms of businesses and the role of corporate knowledge in future enterprise. In addition, they would hear about the implications of a global manufacturing enterprise from different perspectives including US, Europe, Asia and Singapore.

SMA6399 Independent Research Project

Modular credits: 12

Workload: NA-NA-NA-15-20-NA (Total workload: Min of 390 hours over a period of 6 months)

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

This course provides the opportunity for the student to develop his/her independent research capability by conducting an investigation in a topic under the guidance of supervisor(s). Each student is to research independently on an approved topic under the guidance of Supervisor(s). A Thesis is to be submitted at the end of this course. The projects will be chosen to explore innovations in technology, systems and business strategy. These would be in the disciplines of: materials and processes for production, process equipment and tooling, equipment automation and control, metrology and quality control, design for manufacturing, factory system design and control and supply chain design and coordination.

2.830 Control of Manufacturing Processes

Modular credits: 4

Workload: 3-NA-NA-6-3

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

The objective of this MIT subject is to understand the nature of manufacturing process variation and the methods for its control. First, a general process model for control is developed to understand the limitations a specific process places on the type of control used. A general model for process variation is presented and three methods are developed to minimize variations: Statistical Process Control, Process Optimization and in-process Feedback Control. These are considered in a hierarchy of cost-performance tradeoffs, where performance is based on changes in process capability.

15.762 Supply Chain Planning and Design

Modular credits: 4

Workload: 3-1-NA-NA-12

Pre-Requisite(s)/Preclusion(s): NA

Cross-listing: 15.763 (MIT)

The MIT course provides ways to plan and design manufacturing systems and supply chains, with exposure to key tradeoffs and tactics such as inventory, flexibility, risk pooling, batch sizing. Supply chain planning: network inventory models, flow planning, system dynamics, impact of variability and constraints and tactical counter measures, value from supply chain integration for various network topologies and for various market contexts. Manufacturing system design: integration with product development, capacity planning and flexibility, network location decisions, impact of product variety, impact of short product life cycles, make-buy and supplier choice decisions.

M6205 System Simulation and Modeling

Modular credits: 4

Workload: 3-NA-NA-2-5

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

This NTU course provides an insight into how simulation modeling can aid in effective decision-making. The bulk of the time in the course is spent on discrete event simulation modeling. Simulation model building aspects of discrete systems (such as manufacturing and logistics facilities, supply chains) are covered in detail. It also demonstrates how computer simulation can be used to successfully model, analyze and improve systems under study. A simulation software (Arena) is used to demonstrate building and executing the models. Systems dynamics and continuous simulation are also covered in earlier part of the course. The course also covers the topic of simulation life cycle analysis, and goes over issues like model verification and validation. It also looks into the statistical analysis of simulation model output.

M6209 Management of Global Manufacturing Operations

Modular credits: 4

Workload: 3-NA-NA-5-2

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

Companies have begun to realise that globalisation is not only imminent, but is inescapable. As procurement, manufacturing, design, and distribution get shifted to the most economical locations, an organisation finds itself facing new challenges it hadn't encountered before.

Globalisation forces an organisation to deal with issues such as managing cross-cultural, cross-continent material and information flows, and managing inventory spread around the globe. All these issues require changes in management styles and strategies, and organisational structure as well.

One of the main challenge organisations face as they go global is management of global logistics, in this NTU course, we look at the challenges the organisations face and the changes required on their part to deal with those challenges.

M6229 Knowledge Engineering

Modular credits: 4

Workload: 3-NA-NA-5-2

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

This NTU course consists of a series of topics in which the major issues relating to knowledge processing techniques are explored. This includes knowledge based systems, concurrent knowledge processing technique, autonomous agents/actors, machine learning, and tools for the development of knowledge processing systems. A key objective is that at the conclusion of the subject, students will appreciate the major issues and difficulties in implementing useful knowledge processing applications/intelligent systems in business/manufacturing and will be better placed to manage and participate in successful systems projects. In addition, it is hoped that students will enhance their skills in searching new information systems and analysing it critically.

M6303 Fundamentals of Precision Engineering

Modular credits: 4

Workload: 3-NA-NA-5-2

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

Precision Engineering is the multidisciplinary study and practice of high accuracy engineering, metrology, and manufacturing. This course takes an integrated approach to all subjects related to the research, design, manufacture and application of high precision machine tools. This NTU course is designed for students and professionals in industry to acquire an in-depth knowledge and other related topics. Major topics covered include overview of precision engineering; application of displacement transducers to machines and instruments; machine tool control; principles of precision machine design; tolerance technology.

M6321 Precision Mechanism Design

Modular credits: 4

Workload: 3-NA-NA-5-2

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

The technology in Precision Engineering has in recent years advanced from the micro-scale to the nano-scale arena. This NTU course aims to introduce the student to the field of precision engineering and the body of literature in this field. Major topics include concepts in precision design; flexure mechanism; advanced design issues; dynamics and materials; actuator and sensor integration; contact mechanics and coupling; implementation issues relating to precision mechanism.

M6328 Optical Engineering

Modular credits: 4

Workload: 3-NA-NA-5-2

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

This NTU course is designed to give students a firm understanding of the fundamental principles of optical design and examines its engineering applications. Traditional ray and wave (physical) models illustrate optical phenomena, and key design elements such as fibres, lasers and holography are covered. This subject addresses topics such as optics for engineers; light sources and detectors; industrial laser applications and optical systems that provide unique and substantial advantages; optical interferometry; precision manufacturing of optical components.

M6402 Advanced Microprocessor Applications

Modular credits: 4

Workload: 3-NA-NA-5-2

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

Modern manufacturing requires people with the skills to design and produce complex machines to carry out high technology automation. This NTU course equips students with the knowledge and skills required for a career in electronic and mechanical engineering and seeks an understanding of the current approaches and emerging directions in microelectronics. The course covers areas including microprocessor architecture and concepts; microprocessor families; software building blocks and expansion method; I/O interfacing and software development tools; signal processing in mechatronics.

M6421 Advanced Product Design for Manufacture

Modular credits: 4

Workload: 3-NA-NA-5-2

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

Design for Manufacturability is a proven design methodology that works for any size company. Early consideration of manufacturing issues shortens product development time, minimizes development cost, and ensures a smooth transition into production for the quickest time to market. Production costs are lower because simpler designs can be assembled easier with less overhead costs. DFM designs have fewer parts and fewer part types. This, in turn, helps eliminate setup for lean production, build-to-order, and mass customization. Development time & costs are better because of concurrent engineering design teams, modular design, standard design features, common parts, use of existing plant equipment. This results in less "fire-fighting," engineering changes, and less need for redesigns. Quality and reliability are designed for and built in. Major topics of this NTU course include DFM principles and strategies; design for manual assembly; design for automatic assembly; designing for quality; selection of materials and processes; design for injection molding, automatic feeders, design for repair and recycling.

M6429 Thermal Management in Product Design

Modular credits: 4

Workload: 3-NA-NA-5-2

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

This NTU course is intended to introduce the student to the influence on design of the physical environment in general, and the thermal environment in particular, and to the ways in which appropriate techniques of thermal analysis and modelling can be used to enhance product performance and reliability. Major topics covered include thermal issues in product design and thermal management strategies; numerical methods for thermal analysis; heat transfer enhancement and cooling techniques; applications in product design.

M6513 Biomaterials and Biomechanics

Modular credits: 4

Workload: 3-NA-NA-4-3

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

Students taking this NTU course gain a basic understanding of the major areas of interest in both the biomaterials and biomechanics fields, learn to apply basic engineering principles to biomedical systems, and understand some of the challenges and difficulties of biomedical systems. Major topics in biomaterials include overview of materials; structures and properties; metals and ceramics used in medical applications; polymers used in medical applications; natural biomaterials; biodegradation of materials; biocompatibility evaluation and screening. Major topics in biomechanics include bone mechanics; biomechanics of musculoskeletal soft tissue; biomechanics of upper and lower limbs; biomechanics of the spine.

M6521 Cardiovascular Engineering

Modular credits: 4

Workload: 3-NA-NA-5-2

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

This NTU course is designed to give students an outline of the physical processes and mechanism in the circulation system of heart. Introduction to the solid and fluid mechanics and mass transport; the physiological events in the circulation and the physical mechanism; rheology of blood and the circulation system starting with the heart. Major topics covered include An introduction to Basic Ideas in Fluid Mechanics; solid mechanics and the properties of blood vessel walls; oscillations and waves; an introduction to mass transfer; mechanics of the blood circulation; anatomy of the heart; the systemic arteries; the systemic veins.

M6522 Life Support Engineering

Modular credits: 4

Workload: 3-NA-NA-5-2

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

This is an NTU course which includes topics such as Mathematical modelling and computer simulation of physiological and other biomedical systems; application of ordinary and partial differential equations. Bioheat (micro & macro) and biomass transfer models (by diffusion and convection). Concepts of the Nervous System. Benchmarking of bioheat equation for numerical simulation. Principles of thermal imaging, image processing, thermal physiology and skin. Medical applications of thermography preparation of patient, clinical implications. Mass transfer in the systemic circulation. Functional principles and future directions of artificial organs.

6.5 Computation and Systems Biology (CSB)

7.56 Foundations of Cell Biology

Modular credits: 4

Workload: 4-2-NA-4-NA

Pre-Requisite(s)/Preclusion(s)/ Cross-listing(s): NA

This MIT course is designed for graduate students interested in understanding biological processes at the cellular level. Intended to be useful to biologists working in a wide range of areas and to provide the foundation to approach the current literature. The goals are to discuss fundamental topics in cell and molecular biology; demonstrate how the major questions have been approached, technically and intellectually; analyze how one interprets the data produced by those approaches; and identify the questions that remain. Topics covered include macromolecular synthesis, assembly of cellular complexes and structures, control of cell division, and cell signaling. Familiarity with the basics of biochemistry and genetics is assumed.

7.58 Molecular Biology

Modular credits: 4

Workload: 4-1-NA-NA-5

Pre-Requisites: 7.03 Genetics (MIT), 7.05 Biochemistry (MIT)

Cross-listing: 7.28 (MIT)

Preclusion(s): NA

This MIT course provides a detailed analysis of the biochemical mechanisms that control the maintenance, expression, and evolution of prokaryotic and eukaryotic genomes. Topics covered in lecture and readings of relevant literature include: gene regulation, DNA replication, genetic recombination, and translation. Logic of experimental design and data analysis are emphasized. Presentations include both lectures and group discussions of representative papers from the literature. Meets with 7.28; graduate students are expected to explore the subject in greater depth.

7.548J Perspectives in Biological Engineering

Modular credits: 4

Workload: 3-2-NA-3-4

Pre-Requisite: Permission of Instructor

Cross-listing: BE400 (MT)

Preclusion(s): NA

Develops and applies scaling laws, the methods of continuum mechanics and computational models to biomechanical and biochemical phenomena over a range of length scales. Topics include: structure of tissues and the molecular basis for macroscopic properties; chemical and electrical effects on cellular behavior; cell mechanics, motility and adhesion; biomembranes; biomolecular mechanics and molecular motors. information processing in cells. Experimental methods for probing structures at the tissue, cellular, and molecular levels.

7.91J Foundations of Computational and Systems Biology

Modular credits: 4

Workload: 3-NA-NA-3-4

Pre-Requisites: 7.01x, 7.03 and 7.05 (MIT)

Cross-listings: 7.36, BE.490J (MT)

Preclusion(s): NA

Introduction to computational biology emphasizing the fundamentals of nucleic acid and protein sequence and structural analysis, also including an introduction to the analysis of complex biological systems. Covers principles and methods used for sequence alignment, motif finding, structural modeling, structure prediction and network modeling. Includes exposure to currently emerging research areas.

Subject designed for advanced undergraduates and graduate students with strong backgrounds in either molecular biology or computer science. Some foundational material covering basic programming skills, probability and statistics is provided for students with non-quantitative backgrounds.

BS6001 Foundation Course in Molecular and Cell Biology

Modular credits: 4

Workload: 2-2-NA-NA-6

Pre-Requisite: BSc degree in relevant discipline

Preclusion(s)/ Cross-listing(s): NA

The aim of this NTU course is to ensure that the graduate students have the fundamental knowledge on topics of molecular and cell biology. Topics covered include: molecular and cellular mechanisms, genomic manipulations, control of gene expression, molecular immunology, virology, cancer biology, and hereditary diseases.

BS6002 Foundation Course in Structural, Chemical and Computational Biology

Modular credits: 4

Workload: 2-2-NA-NA-6

Pre-Requisite: BSc degree in relevant discipline

Preclusion(s)/ Cross-listing(s): NA

The aim of this NTU course is to ensure that the graduate students have the fundamental knowledge on topics of structural and computational biology. Topics covered include: computational tools in bioinformatics, biological databases, combinatorial libraries, structural prediction of proteins, biophysical principle of biomolecular assembly, and enzymatic mechanisms.

6.6 Chemical and Pharmaceutical Engineering (CPE)

Information of the courses offered under this programme will be updated at a later date.