

## **NTU CONTEMPORARY PHYSICS**

**NTU CONTEMPORARY PHYSICS** is a fresh look at some topics in contemporary physics research. The course will outline the physical principles that lead to a direct discussion of the prevailing ideas and thought. The course will be taught by NTU professors who themselves are actively engaged in the respective research areas.

The following topics will be covered:

1. Nanoscale Physics – Starting with basic quantum physics and progressing to ideas of quantum confinement, this topic will examine the physical structure and properties of low-dimensional systems and quantum dots. Methods of fabrication (molecular beam epitaxy, chemical vapour deposition) and analytical techniques (microscopy and diffraction) will be discussed in sufficient detail for a strong appreciation of the topic. Finally it takes a look at current research ideas in molecular electronics and photonics.
2. Semiconductor physics – While semiconductors have been known for almost a century, this topic looks at why modern technology is so reliant on this class of material, particularly in logic devices (CMOS transistors) and opto-electronic components (LEDs, photovoltaics). The topic closes with a look at an impending technology involving the property of electron spin in logic and storage devices – an area called spin electronics.
3. Biophysics – This topic begins with a look at the forces in the world of biomolecules (proteins, DNA) and the mechanisms of their motion. The course also introduces about the structure of biomolecules and different modern biophysical methods to study molecular structure and interaction. This is followed by a discussion on the transmission of electrical signals in nerves and ending with physical imaging techniques in medicine.

Pre-requisite: H2 Physics

The course will be conducted through lectures, tutorials and laboratory work, and assessment will be based on the following components:

- Term tests
- Laboratory work
- Final exam

This course cannot be offered together with the MOE H3 Physics course.

For enquiries on application, please contact your JC H3 Co-ordinator.

**2 Hosting Venues: 1. Hwa Chong Institution (HCI) and National Junior College (NJC) /or  
2. Victoria Junior College (VJC) and Temasek Junior College (TJC)**



## **NTU NUMBERS & MATRICES**

**NTU NUMBERS & MATRICES** offers students who have a strong aptitude for, and are passionate about mathematics, an opportunity to further develop their mathematical reasoning skills and enhance their understanding and appreciation of fundamental mathematical tools like number theory and matrix algebra as well as their relevance in modern applications.

The topics covered include: basic number theory (divisibility and modular arithmetic), matrix algebra (solutions of systems of linear equations, properties of matrices, connection with geometry) and vector spaces (basic properties, basis, rank and nullity).

Several applications of these tools are also discussed, including: cryptography (symmetric-key cryptosystems, Hill cipher, RSA cryptosystem), optimization problems (linear programming), coding theory (check digits, error-detecting and error-correcting codes), Internet search engines, genetic and population growth, etc.

There are ample opportunities for students to learn to appreciate and understand the importance of mathematical definitions, to read and write mathematical proofs, to be familiar with useful algorithmic techniques, as well as to explore and appreciate the relevance of mathematical tools in modern technology and applications.

Pre-requisite: H2 Mathematics (particularly Functions and Graphs with emphasis on Equations and Vectors)

Assessment:

Students are assessed based on the following components:

- One 2-hour written Final Examination (70%)
- Two 1-hour written Mid-Term Tests (30% - each test 15%)

For enquiries on application, please contact your JC H3 Co-ordinator.

**2 Hosting Venues: 1. National Junior College (NJC) and Hwa Chong Institution (HCI) /or  
2. Temasek Junior College (TJC)**



## **NTU SEMICONDUCTOR PHYSICS AND DEVICES**

**SEMICONDUCTOR PHYSICS & DEVICES** is designed to stimulate students' interest in science and engineering, and to help them broaden their education experience in a different environment. It is intended for students wishing to pursue deeper studies in physics and semiconductors. Students enrolled in the course will learn the key theorems of semiconductors and operating principles of semiconductor devices. Hands-on sessions on semiconductor materials and devices will be provided. Students will also acquire an understanding and appreciation of the driving force behind the convergence of semiconductor technologies, which is imperative to our daily life, and its evolution through this programme.

Pre-requisite: H2 Physics

### **Assessment:**

- Term tests
- Laboratory assignment (report and viva)
- Final exam

This course cannot be offered together with NTU Contemporary Physics or H3 Essentials of Modern Physics.

For enquiries on application, please contact your JC H3 Co-ordinator.

**Hosting Venue: Hwa Chong Institution (HCI)**



## NTU ORGANIC SYNTHESIS & MECHANISM

Organic Synthesis plays a key role in the improvement of our quality of life. The principles of Organic Synthesis allow the realization of complex molecules that have a wide variety of applications: dyes, flavours, fragrances, polymers, materials and, most significantly, pharmaceuticals. Thus, Organic Synthesis is fundamental to a range of key industries. Synthesis can only be successful when combined with an understanding of the **molecular mechanism** of the transformation. This mechanistic understanding allows students to have a strong grasp of concepts for a better understanding of organic chemistry. In this programme, ideas of synthesis and reaction mechanisms are taught to provide the students with a strong foundation for further studies in Organic Chemistry. In addition to these two central themes, modern spectroscopic methods will also be introduced, mainly as a tool to evaluate the products of organic reactions. Stereochemistry, an important concept in biological molecules and biologically active compounds, will also be taught.

Pre-requisite: H2 Chemistry

### **Assessment:**

- Term tests
- Laboratory assignment
- Final exam

For enquiries on application, please contact your JC H3 Co-ordinator.

**Hosting Venue: Hwa Chong Institution (HCI)**





## **NTU Molecular Biology**

Molecular Biology focuses on the areas of *Biomolecules* and *Recombinant DNA Technology*. *Biomolecules* explores the 3-dimensional structure of biomolecules and offers insights into forces that govern their structure and functions. Students will learn to assess databases and softwares to analyze and to visualize the 3-D structures of biomolecules.

*Recombinant DNA Technology* introduces modern biotechnology concepts and methodologies, which includes DNA/protein manipulation and analysis, mass spectroscopy and NMR. Students will also be introduced to biomedical technologies such as stem cell research, as well as the generation of knockout /transgenic animals. Teaching mode includes lectures, tutorials, computer and wet-lab experiments.

Pre-requisite : H2 Biology  
Assessment : Students undertake two components:

- Wet-Laboratory Practical Report
- Final Examination

For enquiries on application, please contact your JC H3 Co-ordinator.

**Hosting Venue: Raffles Institution (RI)**

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