OÉ Gaillimh
NUI Galway

Physics, chemistry and mathematics – the science behind engineering

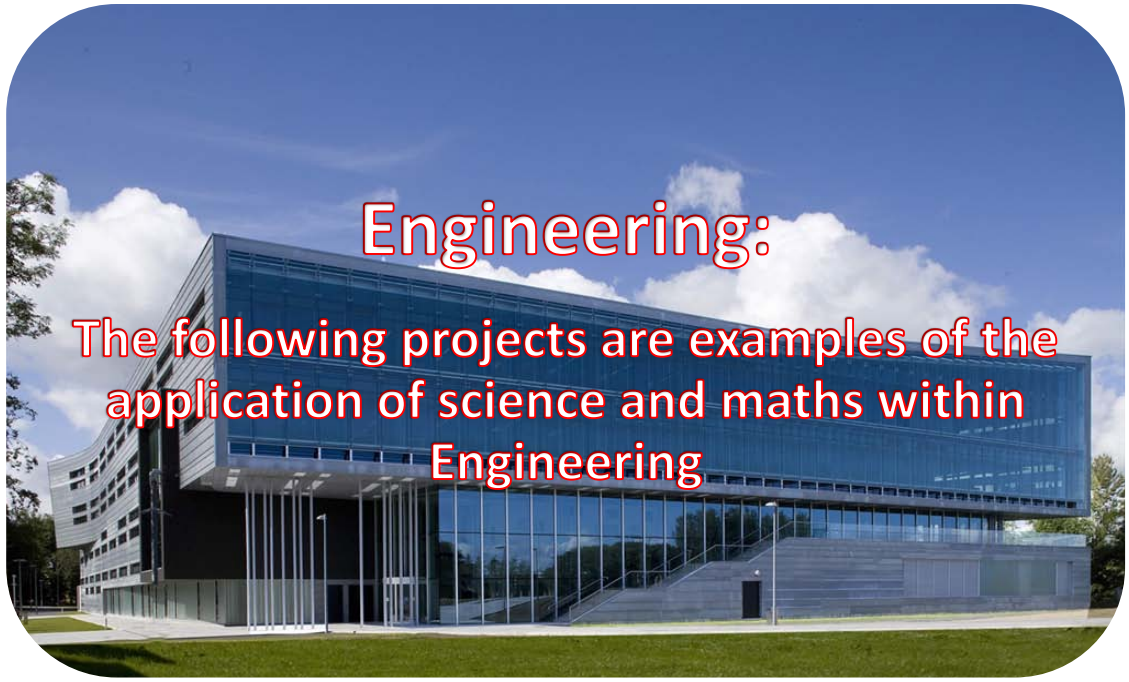
Physics

+

Chemistry

+

Mathematics / Applied Mathematics



The Biomedical Industry:

Civil Engineering

Constructing the buildings other engineers work in.

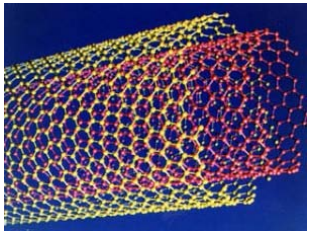
Structural design (Forces, trigonometry, differential equations, matrices)
Energy efficient building (material properties, atomic structure of (e.g. automatic tinting glass)
Water and wastewater (Organic chemistry, kinetics, thermodynamics, chemical reactions, acids and bases used to produce high quality water)

Creganna Medical Devices, Galway. Shown on the right are HVAC systems used to control the indoor climate (www.cregannatactx.com)

Biomedical Engineering

Enabling doctors to diagnose.

MRI, CT and X-Ray scanners (waves, ultrasound, interference, optics, electromagnetism, x-ray theory, radioactivity, atomic theory, electric fields and forces)

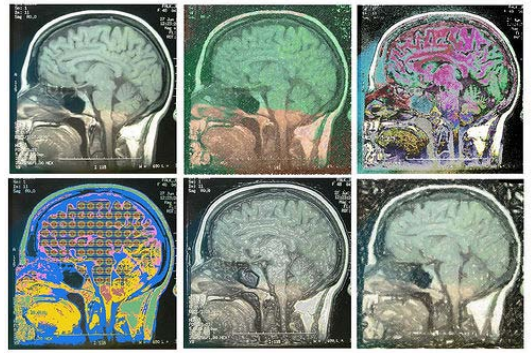


Shown above (Clockwise from top left): Nano device micromesh, implantable cardioverter defibrillators and plating system for fixing fractures (www.x-bolt.com)

Electrical and Electronic/Sports and Exercise Engineering:

Converting signals into images ...

Digital signal processing (complex numbers, matrices, electric fields and forces, line spectra)
Image analysis (complex numbers, matrices, trigonometry and vectors)



MRI scans of the brain (www.d2m-solutions.com)

Mechanical Engineering

Providing services for safe, comfortable and energy efficient buildings.

HVAC systems (climate control), Water services, fire mains and boilers (fluid mechanics, differential equations, laplace transforms, thermodynamics).
Mechanical components (thermal expansion, heat transfer, properties of liquids, polymers, trigonometry)
Building Management Systems for automatic control of heating and cooling systems (matrices, polynomials, differentiation)

Biomedical/Sports & Exercise Engineering

Designing medical products that improve lives

Medical devices (properties of solids and metals, redox reactions, corrosion, polymers and isomers, mechanics, differential equations, matrices)
Drug delivery (fluid mechanics, kinetics, organic chemistry, catalysis, rates of reactions, enzyme catalysis, gas laws and phase change)
Controlling devices including pacemakers and robotic arms for surgery (matrices, integration, root mean squares, trigonometry and vectors, Euclidean geometry)

Energy Systems and electrical engineering:

Something has to power it all.

Power systems e.g. back-up generators (thermodynamics, electromagnetism).
Power/electrical design e.g. high voltage equipment (complex numbers, resistors, capacitors)
Combined heat and power systems (calorific value of fuels, gas laws, energy, charge flow)

Powering Engineering Design using Mathematics, Physics and Chemistry

Foundations and geotechnical engineering:
The foundation is designed to support the loads of the structure and keep it stable

Physics (Newton's laws, wave theory, forces, properties of fluids, experimental methods)
Chemistry (foundation corrosion, redox processes)
Mathematics (integration, differentiation, matrices)

Project Management/Construction:
During construction materials have to be moved and stored. The project must be completed on-time and within budget

Chemistry (material storage, corrosion)
Mathematics (geometry, polynomials, matrices, percentages, statistics)

Mechanical components:
Materials must be resistant to wear and tear.

Chemistry (properties of solids and metals, corrosion)
Physics (torque, thermal expansion, mechanics)
Mathematics (complex numbers, matrices, integration, trigonometry and vectors)

Wind Turbine Foundation (www.sjwconcerete.com)

World's largest wind turbines (www.ge-energy.com)

Wind turbine nacelle and internal components

Wind turbine blades, Belfast (www.harland-wolff.com)

Tower:
The tower supports the wind turbine blades and nacelle in

Physics (static and dynamic loads, forces, dynamics, heat and temperature effects on materials)
Chemistry (Properties of solids and metals, atomic structure, redox processes - corrosion)
Mathematics (Integration and differentiation, matrices)

Project appraisal:
Studies on the technical and financial feasibility of the project take place. Trials on new designs might be necessary.

Physics (experimental methods, dimensional analysis)
Mathematics (statistics & probability, polynomials)

Electrical, electronic & energy systems design:
Electricity is transferred to mains networks with minimal energy losses.

Physics (heat and work, electricity & magnetism, insulators, conductors)
Chemistry (chemistry of solids and metals, atomic structure, semiconductors)
Mathematics (complex numbers, laplace transforms, root mean squares, integration)