



**PES**  
UNIVERSITY  
**ONLINE**

# **ENGINEERING PHYSICS**

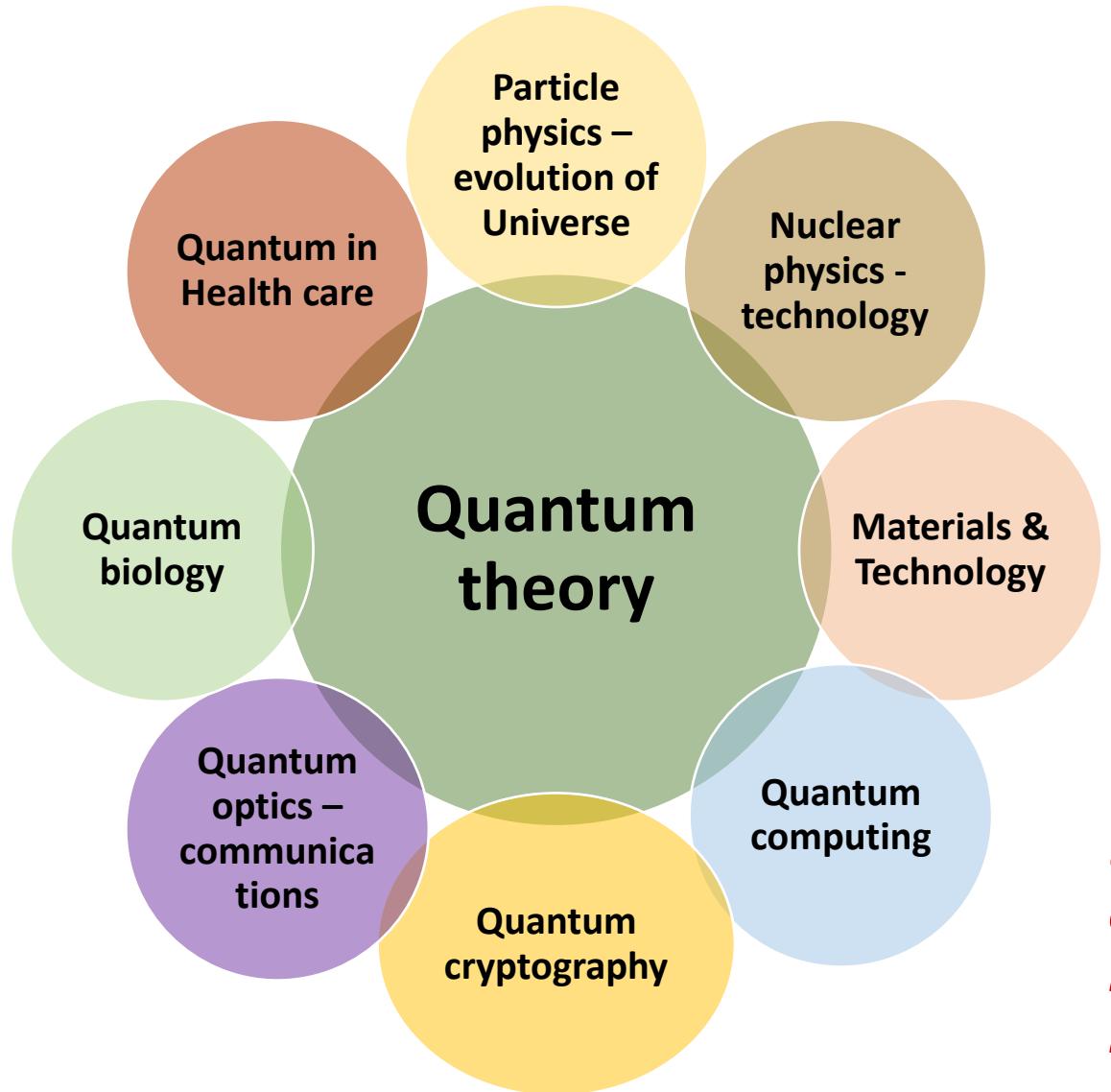
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Department of Science and Humanities

# ENGINEERING PHYSICS

## Quantum theory impacts .....



*The  
universe is  
quantum  
by  
nature.....*

# ENGINEERING PHYSICS

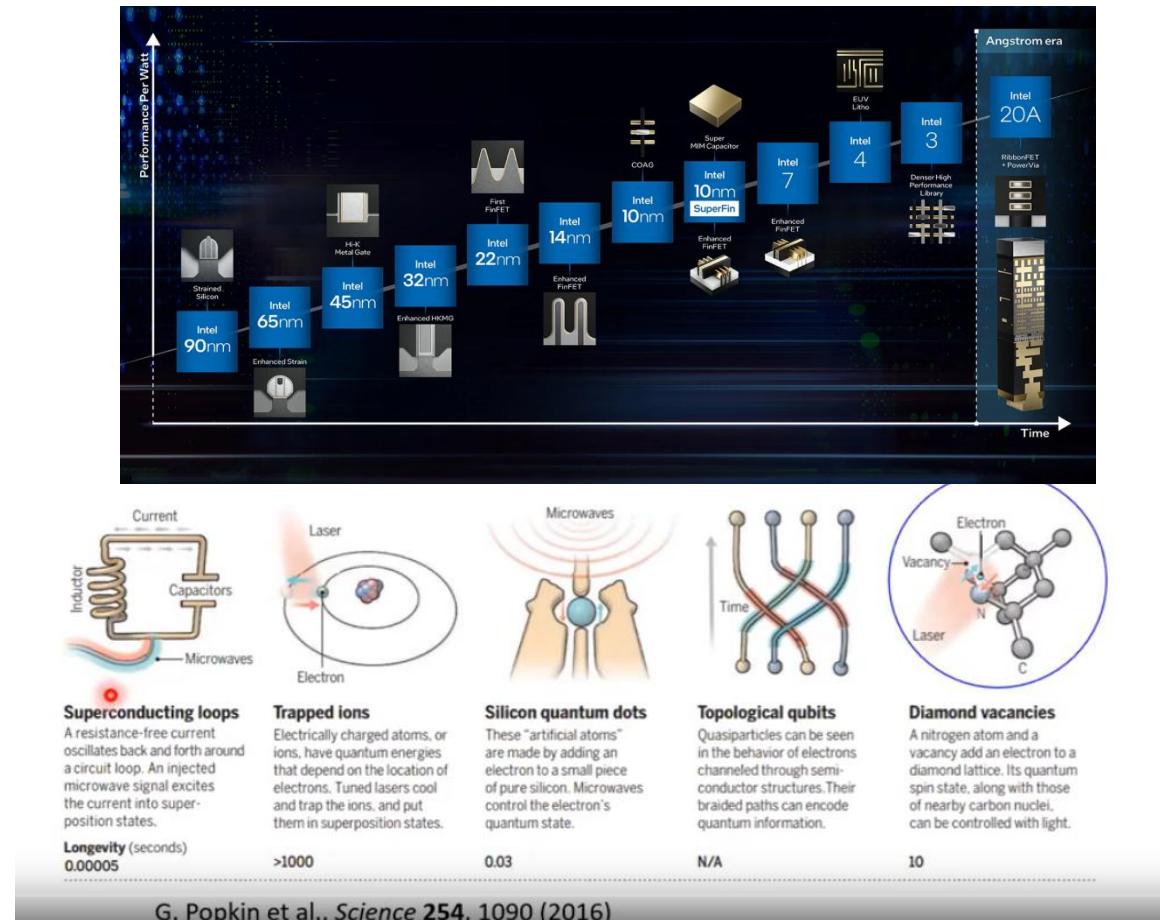
## Relevance of this course to engineering and technology

- **Rapidly evolving technology solutions in small sizes**

- 3 – 5nm VLSI chips
- Quantum dot lasers
- High resolution GPS
- Medical imaging devices
- High density storage devices .....

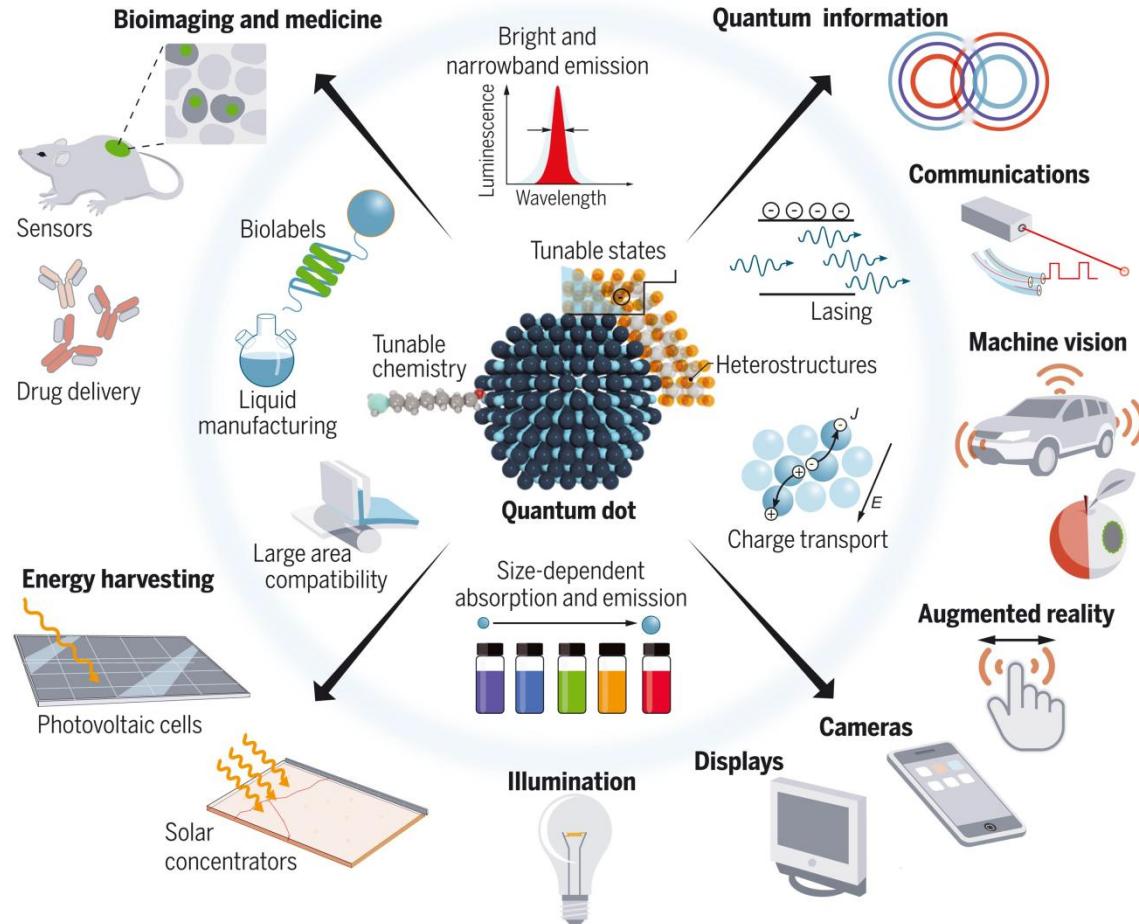
- **Quantum computing**

- Quantum entanglement
- QUBITS
- Quantum computing



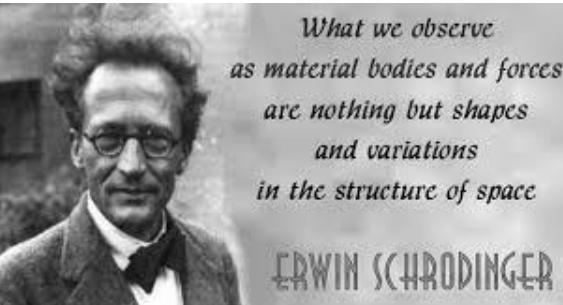
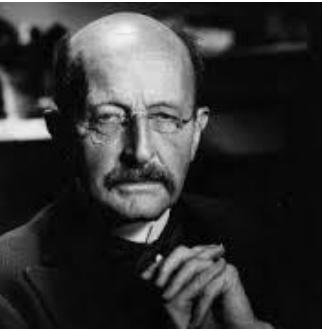
# ENGINEERING PHYSICS

## Relevance of this course to engineering and technology



# ENGINEERING PHYSICS

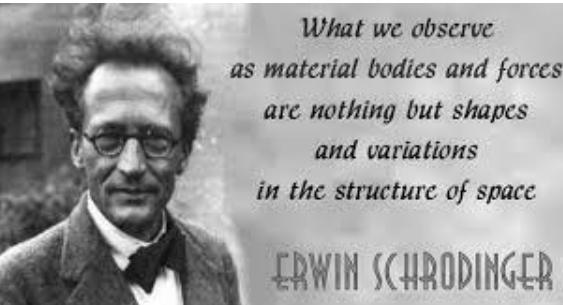
## The galaxy of scientists .....



$\left( \frac{-\hbar^2}{2m} \nabla^2 + V \right) \Psi = i\hbar \frac{\partial \Psi}{\partial t}$

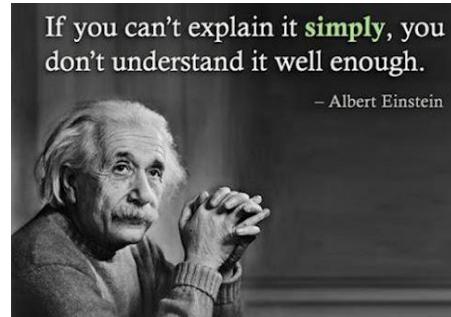
$$\Delta x_i \Delta p_i \geq \frac{\hbar}{2}$$

Werner Heisenberg (1901-1976)  
Winner of the 1932 Nobel Prize in Physics

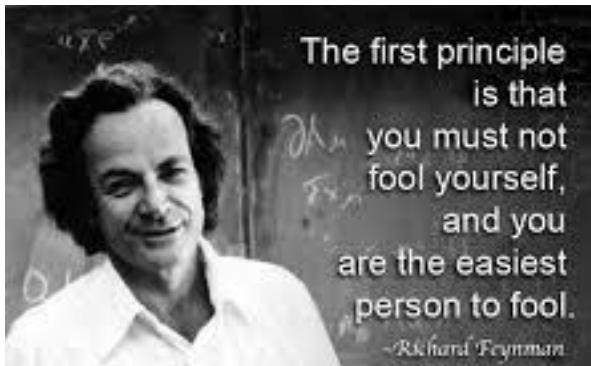


*What we observe  
as material bodies and forces  
are nothing but shapes  
and variations  
in the structure of space*

ERWIN SCHRODINGER



If you can't explain it **simply**, you  
don't understand it well enough.  
— Albert Einstein



The first principle  
is that  
you must not  
fool yourself,  
and you  
are the easiest  
person to fool.

Richard Feynman

.. and many more

# ENGINEERING PHYSICS

## The simple mathematics....

$$\langle \phi_n | \phi_{n'} \rangle = \left\langle \phi_n \left| \int dx |x\rangle \langle x| \phi_{n'} \right. \right\rangle \Rightarrow \left( \sum_{k=0}^{\infty} n+k \delta_k \right) \frac{1}{L} = \frac{\pi}{2} (2\ell-1), \ell=1, 2, \dots \Rightarrow k_0 = -\frac{\pi}{2}$$

$$\langle \phi_n | \phi_{n'} \rangle = \int dx \phi_n^*(x) \phi_{n'}(x) \quad \Psi_n(x) = \sqrt{\frac{2}{L}} \cos \left[ \frac{\pi}{L} (2n-1)x \right]; \quad \Psi_{n'}(x) = \sqrt{\frac{2}{L}} \sin \left[ \frac{\pi}{L} (2n'-1)x \right]$$

$$\langle \phi_n | \phi_{n'} \rangle = \frac{1}{L} \int dx e^{-ik_n x} e^{ik'_{n'} x} \stackrel{x=0; h \neq 0}{=} 0; \quad \hat{H} \Psi_{n'}(x) = -\frac{\hbar^2}{2m} \partial x^2 \Psi_{n'}(x) = \frac{\hbar^2}{2m} \left( \frac{\pi}{L} [2n-1] \right)^2 \Psi_{n'}(x)$$

$$E_{n'} = \frac{\hbar^2}{2m} \frac{\pi^2}{L^2} (2n-1)^2, \quad n=1, 2, \dots; \quad \hat{H} \Psi_{n'}(x) = \frac{\hbar^2}{2m} \left( \frac{2\pi}{L} \right)^2$$

$|\Psi(x)|^2 = |\Psi_0|^2 e^{-\frac{(x-x_0)^2}{2a^2}}$

$\int dx e^{-Ax^2} = \sqrt{\frac{\pi}{A}}$

$A = \frac{1}{2a^2} \Rightarrow |\Psi_0| = \frac{1}{(2\pi a^2)^{1/4}}$

$\langle \hat{p}, \hat{x} \rangle = \frac{\hbar}{i}; \quad \hat{p} = \frac{\hbar}{i} \partial_x / \hat{H} = \frac{\hbar^2}{2m} r \frac{1}{2} m \omega^2 \hat{x}^2$

1.  $a^2 + b^2 = (a+ib)(a-ib); \quad a, b \in \mathbb{R}; \quad 2. \quad (\hat{a}\hat{p} + ib\hat{x})(a\hat{p} - ib\hat{x}), \quad a, b \in \mathbb{R}$

$= a^2 \hat{p}^2 + iba\hat{x}\hat{p} - iab\hat{p}\hat{x} + b^2 \hat{x}^2 = a^2 \hat{p}^2 + b^2 \hat{x}^2 - bat$

$\hat{H} = (a\hat{p} + ib\hat{x})(a\hat{p} - ib\hat{x}) = bat; \quad a^2 = \frac{1}{2m}; \quad b^2 = \frac{1}{2} m \omega^2$

$Dg: C^+ = \frac{1}{\hbar \omega} (a\hat{p} + ib\hat{x}); \quad C^- = \frac{1}{\hbar \omega} (a\hat{p} - ib\hat{x}) \Rightarrow \hat{H} = \hbar \omega C^* C$

$\int (n - \frac{1}{2}) |n\rangle \langle n| \in \mathbb{C} \quad \int \pm 1 \in SU(2)^2 S^3 \quad A \rightarrow \omega, \bar{\omega}, \omega^{-1} + \frac{1}{2} \hbar \omega$

$$\lambda = \frac{\hbar^2}{m 4 a^4} \Rightarrow \omega = \frac{\pi}{2 m a} \quad E_0 = \frac{\hbar^2}{2 m} \frac{1}{2a}$$

$$\langle (x-x_0)^2 \rangle = \langle \Psi_0 | (x-x_0)^2 | \Psi_0 \rangle = \int dx |x\rangle \langle x| (x-x_0)^2$$

$$= \int dx \Psi_0^*(x) (x-x_0)^2 |x\rangle \Psi_0(x)$$

$$= \int dx \Psi_0^*(x) (x-x_0)^2 |x\rangle = x |x\rangle$$

$$= \int dx \Psi_0^*(x) (x-x_0)^2 |x\rangle \Psi_0(x)$$

### Prerequisites:

- 1. C grade in the Physics course at the 11<sup>th</sup> and 12<sup>th</sup> grade**
- 2. A good understanding of EM waves and Modern Physics topics in the 11<sup>th</sup> and 12<sup>th</sup> grade**
- 3. Basics ideas of Mathematics - differential equations and their solutions, concepts of integration, exponential functions, series expansions, fundamental concepts of Probability ( 11<sup>th</sup> and 12<sup>th</sup> grade)**

**Unit I: Review of concepts leading to Quantum Mechanics**

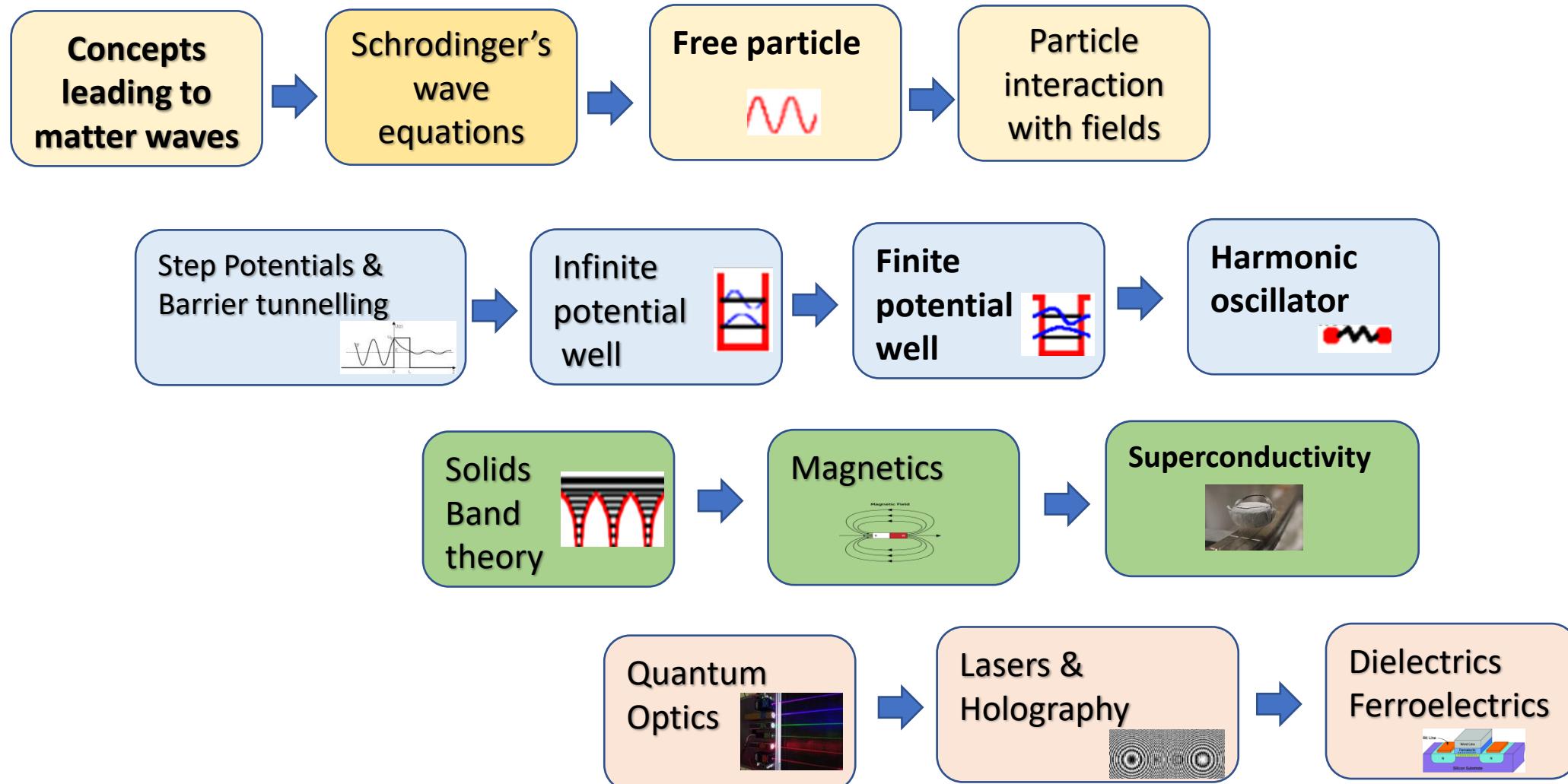
**Unit II: Quantum Mechanics and Simple Quantum Mechanical Systems**

**Unit III: Application of Quantum Mechanics to electrical transport in Solids and treatment of Magnetics**

**Unit IV: Application of Quantum Mechanics to Optical waves;  
Concepts of polarisation and Dielectrics / ferroelectrics**

# ENGINEERING PHYSICS

## The flow .....



➤ **Suggested Textbook:**

1. *Concepts of Modern Physics, Arthur Beiser, Chapters 1,2,3,5 and 10*

➤ **Additional reference:**

1. *Learning materials prepared by the Department of Physics*
2. *“Quantum Physics of Atoms Nuclei and Molecules”, Robert Eisberg, Robert Resnick, Wiley, 2006.*
3. *“Quantum Physics”, S Gasiorowicz, 3rd Edition, Wiley Publications, 2007*
4. *“Lectures on Physics”, Feynman, Leighton and Sands, Vol. 1-3, 13th Reprint, Narosa Publications, 2012*

# ENGINEERING PHYSICS

## Discussion forum .....

➤ <https://forum.pesu.io/>



A screenshot of the PESU Forums website. At the top left is the PESU FORUMS logo. At the top right are search, filter, and settings icons. A blue banner at the top contains two links: "Click here for the Student Declaration Form" and "Click here for the Attendance Request Form". Below the banner, the navigation bar shows "Faculty of S&amp;H" and "Engineering Physics" as selected categories, with "all tags" and "Latest" and "Top" options. There is also a "New Topic" button and a notification bell icon. The main content area displays a table for topics. The columns are "Topic", "Replies", "Views", and "Activity". One topic is listed: "About the Engineering Physics category", which is described as "This category is for Engineering Physics (UE19PH101) from the S&amp;H department." The table has red horizontal highlights under the first three columns.

### In Semester Assessment :

#### Assignments

- at the end of every week with deadlines (10m)
- Open Book Tests, Numericals, Short answers / Seminars

#### Internal Assessment tests

- Computer Based / Hybrid Tests duration 60 minutes at the end of
  - Unit I & Unit II and
  - Unit III & Unit IV
- Each Unit has a weightage of 20 Marks –
  - 8 MCQs, 2 short answers 2M each, 2 long answers 4M each
- No retest for Missing tests

# ENGINEERING PHYSICS

## The grading mechanism .....

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### In Semester Assessments

Computer Based Tests - 40 marks

Assignments - 10 marks

Total for ISA - 50 marks

Experiential Learning - 20 marks

### End Semester Assessments

- Pen and paper examination of 3hrs duration (100m)

### Final Grading for 100 marks =>

(50 marks from ISA + 50%ESA + 20 marks for experiential learning) normalised to 100 marks



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**Best Wishes &  
THANK YOU**

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