



A model structure for flexible and choice based course, its modules and question paper for First year Undergraduate students.

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Abstract

The National policy on education 1986 and its program action 1992, National education policy 2020 have one of their goals for giving flexibility to choose the learning content, courses and programs across different sections of subject, different subject of same discipline, different subjects or modules of different disciplines. Institutions have coming up different modified courses and programmes suiting their needs and necessities. In most of the cases, the student's choice for picking up the modules, subjects and courses was not given much priority compared to other's individualised priorities. An attempt is made in this paper to Design and develop a model structure for flexible and choice based course, its modules and question paper for First year Undergraduate students. The Programme, Course, modules and the design of the questions chosen in this paper are indicative in nature.

Introduction

Flexibility and ability to choose learning content, courses and programs based on learner's interest is one of the goals of New Education Policy. In the context of the flexibility given to the student to choose different modules in a course, it has become necessary to bring out a change in the structure of the question paper used to assess the student in the examinations, either in the mid semester or at the end-semester. In general a course opted by the entire batch of the students will have a common course name in order to bring commonality in the program structure. As the flexibility has been provided to student to choose the modules of their own interest and in some cases as multi-disciplinary modules or modules chooses to gain more credits, number of question papers cannot be designed with a common course name for utilisation by groups of such students opted those particular modules. Hence a study has been made in developing the common course examination paper catering the needs of the students who have opted for different modules under the same course name and the results were presented in this paper.

Methodology

The objective of this study was to bring out the examination paper structure that fits to the requirement as discussed earlier. For taking the project forward, first the number of questions that the examination paper should contain was fixed. For this literature survey was made with special reference to the limitation on the descriptive questions that can be given in general question paper. No fruitful results were obtained from the literature. Search engines like google and AI tools like ChatGPT were used. Some of the old CBSE papers contain as large as 34. It was concluded that there is no specific limitations on the questions. The chatGPT has answered the following:

The maximum number of questions that a question paper can contain depends on several factors, including the duration of the exam, the complexity of the questions,

and the level of the exam (e.g., high school, undergraduate, graduate). Here's a rough guideline:

High School Level: For high school exams, which typically cover a broad range of topics and may have shorter answer lengths, the maximum number of questions might range from 50 to 100.

Undergraduate Level: For undergraduate exams, where a deeper understanding of the material is often required, the maximum number of questions might range from 30 to 80.

Graduate/Professional Level: At higher levels of education, where exams often demand more critical thinking and analysis, the maximum number of questions might range from 20 to 60.

It's important to note that having too many questions can overwhelm students and may not allow them enough time to provide thoughtful responses. Additionally, the quality of questions is more important than the quantity. It's essential to ensure that each question is relevant, fair, and appropriately challenging for the level of the exam.

Ultimately, the maximum number of questions should be determined based on the objectives of the exam, the time available, and the need to provide a fair and comprehensive assessment of students' knowledge and skills. Balancing the number of questions with the available time is crucial to creating an effective and manageable exam experience for students. “ ”

Secondly the number of sections that the examination paper should contain was fixed. Some of the old CBSE papers contain as large as 7. ChatGPT suggested the following:

The number of sections in a question paper can vary depending on various factors such as the level of the exam, the subject matter, and the organization of the curriculum. However, here are some common structures for question papers:

Single Section: Some question papers consist of only one section where all the questions are presented sequentially. This format is commonly used for shorter exams or when the topics covered are closely related.

Multiple Sections: Question papers may also be divided into multiple sections, each focusing on different topics or areas of the subject. For example, a question paper for a science exam might have separate sections for physics, chemistry, and biology. This format allows for a more organized presentation of questions and can help students manage their time effectively.

Optional Sections: In some cases, question papers may include optional sections where students can choose to answer questions from a selection of topics. This format provides flexibility for students to demonstrate their strengths and preferences within the exam.

Compulsory and Elective Sections: Question papers may also have a combination of compulsory and elective sections. Compulsory sections contain questions that all students must answer, while elective sections offer a choice of questions from which students can select based on their interests or strengths.

The number of sections in a question paper should be determined based on the objectives of the exam, the breadth and depth of the curriculum, and the time available for the examination. It's important to ensure that the structure of the question paper aligns with the learning outcomes of the course and provides a fair and comprehensive assessment of students' knowledge and skills.

During the data collection, it was noticed that in the case of CBSE four different courses were also joined as a single question paper with the title “Social sciences”. However in this study only one course was chosen.

For Deciding the maximum number of sections and Questions, a survey was conducted among 458 First year B.Tech students of three engineering colleges situated in Hyderabad using google form with 9 questions. Out of the 487, Only 412 students have given their responses. The final decision was made based on highest number of choices made by the survey participants. The questions were necessary as the input for this study were considered and presented in this paper. Based on the survey results, the maximum number of sections was fixed as 8 and the maximum number of questions was fixed as 30.

With this as the input, a model course, model modules and a model question paper was designed assuming the students who are taking them are First year B.Tech, belonging to all branches. The common course is chosen as the Applied Physics which was a basic science course for Engineering students across the country including IITs, NITs and reputed universities and reputed technical institutions whose NIRF rankings are in the range 1 to 100. The complete study of presence of Physics as a basic science course under different variant names and its relevance in the Engineering programmes and its results will be presented in our next communication.

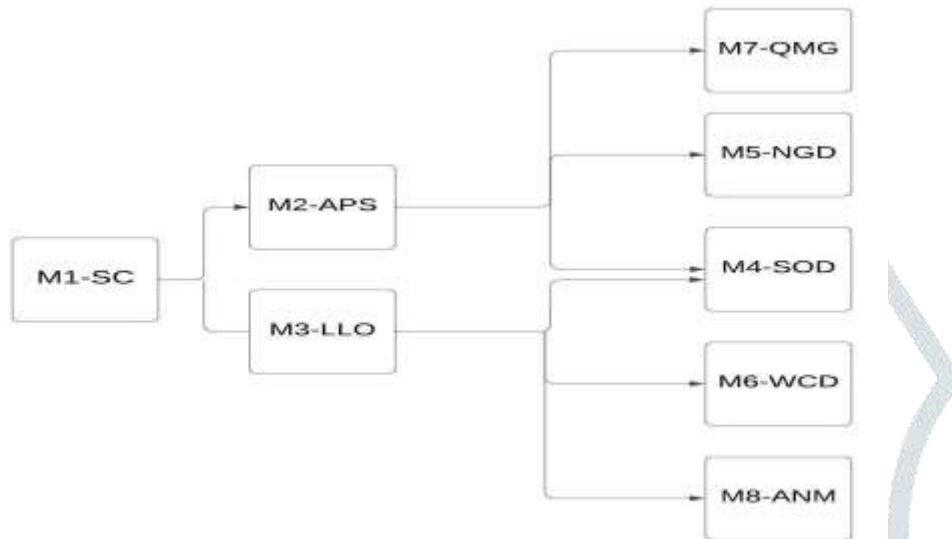
The chosen Applied Physics Course was divided into Eight modules and these modules along with the model syllabus were presented in Table.1.

S.No	Module Code	Module Name	Model Content
1	M1-SCS	Semiconductors	
2	M2-APS	Applied Physics through Scilab	
3	M3-LLO	Light, lasers and Optical Fibres	
4	M4-SOD	Semiconductor Devices and Optoelectronic Devices	
5	M5-NGD	Number systems, Logic gates and Logic Design	
6	M6-WCD	Waves and oscillations, crystal structure and diffraction	
7	M7-QMG	Quantum mechanics and Quantum gates	
8	M8-ANM	Advanced Bulk materials and Nano materials	

The following assumption were made here for further discussion of this paper.

1. All these modules were offered to the students at the beginning of the semester and students were asked to choose the modules of their own choice keeping in mind the their branch of a engineering into which they were admitted.
2. The maximum number modules that a student has to select is FIVE.
3. The selection of Module M1-SC is compulsory for all students.
4. Every student has to select ONE out of M2-APS and M3-LLO modules.
5. Every student has to ONE Module out of the remaining five modules i.e M4-SOD or M5-NGD or M6-WCD or M7-QMG or M8-ANM.
6. However, the students who selected Module M2-APS are advised to prefer M4-SOD or M5-NGD or M7-QMG and the students who selected Module M3-LLO are advised to prefer M4-SOD or M6-WCD or M8-ANM.

This selection of modules is shown as flow chart in the following figure.



This provides six ways for the students to select the modules for their course. The allowed combinations are as follows:

- M1-SC, M2-APS, M7-QMG
- M1-SC, M2-APS, M5-NGD
- M1-SC, M2-APS, M4-SOD
- M1-SC, M3-LLO, M4-SOD
- M1-SC, M3-LLO, M6-WCD
- M1-SC, M3-LLO, M8-ANM

Three teachers can handle all the eight modules in the time flow, provided the teacher is willing to teach modules in the last half of the semester, taking up two modules in different times for different groups of students.

The Challenge of designing a single question a paper for the entire course was taken up by fixing the number of questions that can be answered by the students in 3 hours of time at the level of Under-graduation as FIVE. Out of these FIVE, difficulty level distribution is as follows:

- Lower degree of difficulty: ONE
- Moderately difficult : TWO
- Difficult: TWO.

Lower Difficult level question will be from M1-SC.

One Moderately difficult question and ONE difficult question will be given from the other two modules respectively *i.e*

One Moderately difficult question from M2-APS and M3-LLO

One difficult question from M2-APS and M3-LLO

One Moderately difficult question from M4-SOD or M5-NGD or M7-QMG

One difficult question from M4-SOD or M5-NGD or M7-QMG

One Moderately difficult question from M6-WCD or M8-ANM

One difficult question from M6-WCD or M8-ANM

In order to accommodate the constraints, the question paper is divided into three parts.

Part-1 is compulsory. In this One question has to be answered out of the two questions give. This covers the module M1-SC.

Part-2 will have two sections, section-A and Section B. Section A covers the module M2-APS and Section B covers the module M3-LLO. The student has to answer either section A or Section B. Both these sections will have two questions one at moderately difficulty level and other at difficult level. Both questions will have internal choice.

Part-3 will have FIVE sections out of which the student has to answer only one section. This part covers all the remaining modules other than covered in Part-1 and part-2. Each section covers one module with the structure similar to sections of part-2. Each section will have two questions, one at moderately difficulty level and other at difficult level. Both questions will have internal choice.

All these parameters were given to chatGPT and asked for generation of question paper. However, the question paper generated by chatGPT could not meet all the requirements expected even after modifying the question several times. Hence few modifications were made to the most closer question paper and presented and taken as the model paper, as the outcome of this study.

Applied Physics Examination

Time: 3 Hours

Total Marks: 100

Please read the instructions carefully.

This question paper Contains THIRTY questions, THREE parts, and EIGHT sections.
All Questions carry Equal marks (5 x 20 = 100)

*Part-1 contains Section A, which is **compulsory**.*

*Part-2 contains two sections. Answer **ONE** section, either section-B or Section C.*

*Part-3 contains FIVE sections. Answer **only ONE** out of FIVE sections of your choice.*

Part-1: Section A (Compulsory)

(20 x1 = 20 marks)

Section A: Semiconductors (M1-SCS)

Question 1: Explain the concept of energy band gap in semiconductor materials. How does the band gap affect the electrical conductivity and optical properties of semiconductors?

(OR)

Question 2: Discuss the process of semiconductor doping. Explain the difference between n-type and p-type doping and their effects on semiconductor behaviour.

Part-2: Choose Either Section B or Section C

Section B: Applied Physics through Scilab (M2-APS)

(20 x 2 = 40 marks)

Question 3: Explain how to create custom functions in Scilab and call them within your script.

(OR)

Question 4: Using Scilab, simulate the motion of a simple pendulum with a given length and initial displacement. Plot the displacement versus time graph for the pendulum motion.

Question 5: Describe the process of plotting a 2D graph using Scilab, including how to customize the appearance of the plot.

(OR)

Question 6: Write a Scilab code for determination of wavelength of light in the case of Newton Rings Experiment.

Section C: Light, Lasers, and Optical Fibres (M3-LLO)

(20 x 2 = 40 marks)

Question 7: Describe the conditions required for interference to occur between two coherent sources. How does the path difference between the sources affect the resulting interference pattern?

(OR)

Question 8: What is polarization of light, and how does it differ from unpolarized light? Discuss the construction and working of Nicol Prism.

Question 9: Explain the principle of operation of an optical fiber. Discuss the advantages of optical fibers over traditional copper wires in communication systems.

(OR)

Question 10: Describe the working principle of a laser. Discuss the process of stimulated emission and how it leads to the amplification of light in a laser cavity.

Part-3: Choose ONE Section from Sections D, E, F, G, or H

Section D: Semiconductor Devices and Optoelectronic Devices (M4-SOD)

(20 x 2 = 40 marks)

Question 11: Discuss the working principle of a photovoltaic cell. Explain the process of photogeneration of electron-hole pairs and the generation of electrical energy in a photovoltaic cell.

(OR)

Question 12: Explain the concept of optoelectronic devices. Discuss the applications of optoelectronic devices in areas such as communication, sensing, and lighting.

Question 13: Describe the working principle of a light-emitting diode (LED). Discuss the advantages of LEDs over traditional incandescent bulbs.

(OR)

Question 14: Discuss the operation of a photodiode. Explain its applications in optoelectronic devices and its advantages over other photodetectors.

Section E: Number Systems, Logic Gates, and Logic Design (M5-NGD)

(20 x 2 = 40 marks)

Question 15: Convert the following binary number into its hexadecimal and octal equivalents:

110110102110110102.

(OR)

Question 16: Design a logic circuit that implements the Boolean expression $F=A'BC+AB'C'+ABC$. Draw the circuit diagram and simplify the expression using Boolean algebra.

Question 17: Explain the concept of logic gates. Discuss the different types of logic gates and their truth tables.

(OR)

Question 18: Design a combinational logic circuit to implement a 2-bit binary to Gray code converter.

Section F: Waves and Oscillations, Crystal Structure, and Diffraction (M6-WCD)

(20 x 2 = 40 marks)

Question 19: Discuss the concept of crystal structure in solids. Explain the difference between crystalline and amorphous solids, and give examples of each.

(OR)

Question 20: Explain the phenomenon of diffraction of waves. Describe how the diffraction pattern is formed when light passes through a single slit and when it passes through a double slit.

Question 21: Explain the concept of damping. Derive the expression for the damped harmonic oscillator..

(OR)

Question 22: What is an external force. How the external force changes the motion of damped harmonic oscillator and leads to resonance.

Section G: Quantum Mechanics and Quantum Gates (M7-QMG)

(20 x 2 = 40 marks)

Question 23: Explain the postulates of quantum mechanics. Discuss the concept of superposition and how it is utilized in quantum computing.

(OR)

Question 24: Describe the basic principles of quantum gates. Explain how quantum gates manipulate qubits to perform quantum computations.

Question 25: Discuss the concept of quantum entanglement. Explain its significance in quantum computing and communication.

(OR)

Question 26: Explain the working principle of a quantum computer. Discuss its advantages over classical computers and potential applications.

Section H: Advanced Bulk materials and Nano materials (M8-ANM)**(20 x 2 = 40 marks)**

Question **27**: Discuss the properties and applications of carbon nanotubes. Explain how the unique structure of carbon nanotubes leads to their exceptional mechanical, electrical, and thermal properties.

(OR)

Question **28**: Explain the concept of nanomaterials. Discuss the applications of nanomaterials in fields such as medicine, electronics, and energy storage.

Question **29**: Describe the synthesis methods of advanced bulk materials. Discuss their properties and potential applications.

(OR)

Question **30**: Explain the properties and applications of graphene. Discuss its potential impact on various industries and future technological advancements.

Discussion

The question paper designed in this study was examined for its complexity in understanding by taking the opinion from 129 students and 17 teaching staff members belonging to three different institutions. This was done by sending a questionnaire containing Six descriptive questions through google form. The critical analysis of the results and the conclusions drawn will be reported very soon. The answers for some of the opinions /questions raised by the respondents will be discussed here.

Opinion1. The Question paper seems to be lengthy.

Out of 146 respondents 23 are of this opinion. 22 students and One teacher has this opinion

Opinion2. The number of sections are high.

Out of 146 respondents 3 people have not expressed their opinion. Out of the remaining 18 respondents have expressed this opinion. 17 students one teacher has this opinion.

Two respondents suggested to keep the section headings and marks in bold letters in order to provide the clarity.

It is the first impression that any person who have undergone education in institutions which they were assessed by a single page or two-page question paper containing 10 to 12 questions. Most of these question papers will contain only one or two sections. The question paper setters will mostly depend upon the previous question papers in setting up the questions and repeat the questions such that they cover at least half of the unit of syllabus in toto.

However, The CBSE question paper of class XII English contains 60 Questions distributed over FIVE section. The question paper will be given in the form of a booklet. Different sections contain different number of questions and deal with different topics of English. The students are comfortably answering without any grievance at class XII.

Further, NCERT has designed a question paper for class IX, Mathematics students after careful discussion and study, with 30 questions in FOUR sections without any overall choice. Only 3 out of 30 questions were provided with internal choice. The students of class IX could understand the question paper without any confusion comfortably answering without any grievance.

Two respondents suggested to keep the section headings and marks in bold letters in order to provide the clarity.

Conclusions

A model structure for flexible and choice based course, its modules and question paper for First year Undergraduate students was designed and presented here. This can be taken as template for any program, any course and of any standard. This provides a flexibility for the institution to offer course with different modules and giving choice to the student to choose the modules he/she would like to opt. This provides a wider option for teacher and taught for the selection of the course content. This also avoids the repetitive learning.

As questions, modules and the course are indicative in nature, the standard of difficulty of the questions, modules and the course can be changed according to the institutional and stakeholder's needs.

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Annexure

Question for Chatgpt

Design a question paper containing THIRTY questions, THREE parts and EIGHT sections covering the modules given below.

M1-SCS	Semiconductors
M2- APS	Applied Physics through Scilab
M3- LLO	Light, lasers and Optical Fibres
M4-SOD	Semiconductor Devices and Optoelectronic Devices
M5-NGD	Number systems, Logic gates and Logic Design
M6-WCD	Waves and oscillations, crystal structure and diffraction
M7-QMG	Quantum mechanics and Quantum gates
M8-ANM	Advanced Bulk materials and Nano materials

Part-1 : Section A is compulsory and covers Question 1 and 2.

Part-2 : contains Section B and Section C. The student has to choose only one section, either B or C.

Part-3: Contains Sections D,E,F,G,H. The students has to answer only one section D or E or F or G or H.

Question 1 and 2 are from M1-SCS module with internal choice.

Question 3,4,5,6 are from M2- APS Applied Physics through Scilab module.

Question 3 and Question 4 are of internal choice with OR.

Question 5 and Question 6 are of internal choice with OR.

Question 7,8,9,10 are from M3- LLO Light, lasers and Optical Fibres module.

Question 7 and Question 8 are of internal choice with OR.

Question 9 and Question 10 are of internal choice with OR.

Question 11,12,13,14 are from M4-SOD Semiconductor Devices and Optoelectronic Devices module.

Question 11 and Question 12 are of internal choice with OR.

Question 13 and Question 14 are of internal choice with OR.

Question 15,16,17,18, are from M5-NGD Number systems, Logic gates and Logic Design module.

Question 15 and Question 16 are of internal choice with OR.

Question 17 and Question 18 are of internal choice with OR.

Question 19,20,21,22, are from M6-WCD Waves and oscillations, crystal structure and diffraction module.

Question 19 and Question 20 are of internal choice with OR.

Question 21 and Question 22 are of internal choice with OR.

Question 23,24,25,26, are from M7-QMG Quantum mechanics and Quantum gates module.

Question 23 and Question 24 are of internal choice with OR.

Question 25 and Question 26 are of internal choice with OR.

Question 27,28,29,30, are from M8-ANM Advanced Bulk materials and Nano materials module.

Question 27 and Question 28 are of internal choice with OR.

Question 29 and Question 30 are of internal choice with OR.

Chatgpt answer

Design a question paper containing THIRTY questions and EIGHT sections covering the modules given below. M1-SCS Semiconductors M2- APS Applied Physics through Scilab M3- LLO Light, lasers and Optical Fibres M4-SOD Semiconductor Devices and Optoelectronic Devices M5-NGD Number systems, Logic gates and Logic Design M6-WCD Waves and oscillations, crystal structure and diffraction M7-QMG Quantum mechanics and Quantum gates M8-ANM Advanced Bulk materials and Nano materials Question 1 and 2 are from M1-SCS module with internal choice. Question 3,4,5,6 are from M2- APS Applied Physics through Scilab module. Question 3 and Question 4 are of internal choice with OR. Question 5 and Question 6 are of internal choice with OR. Question 7,8,9,10 are from M3- LLO Light, lasers and Optical Fibres module. Question 7 and Question 8 are of internal choice with OR. Question 9 and Question 10 are of internal choice with OR. Question 11,12,13,14 are from M4-SOD Semiconductor Devices and Optoelectronic Devices module. Question 11 and Question 12 are of internal choice with OR. Question 13 and Question 14 are of internal choice with OR. Question 15,16,17,18, are from M5-NGD Number systems, Logic gates and Logic Design module. Question 15 and Question 16 are of

internal choice with OR. Question 17 and Question 18 are of internal choice with OR. Question 19,20,21,22, are from M6-WCD Waves and oscillations, crystal structure and diffraction module. Question 19 and Question 20 are of internal choice with OR. Question 21 and Question 22 are of internal choice with OR. Question 23,24,25,26, are from M7-QMG Quantum mechanics and Quantum gates module. Question 23 and Question 24 are of internal choice with OR. Question 25 and Question 26 are of internal choice with OR. Question 27,28,29,30, are from M8-ANM Advanced Bulk materials and Nano materials module. Question 27 and Question 28 are of internal choice with OR. Question 29 and Question 30 are of internal choice with OR.

ChatGPT

ChatGPT

Here's a question paper with 30 questions and 8 sections covering the specified modules and internal choice criteria:

Question Paper

Section A: Semiconductors (M1-SCS)

Question 1: Explain the concept of energy band gap in semiconductor materials. How does the band gap affect the electrical conductivity and optical properties of semiconductors?

(OR)

Question 2: Discuss the process of semiconductor doping. Explain the difference between n-type and p-type doping and their effects on semiconductor behavior.

Section B: Applied Physics through Scilab (M2-APS)

Question 3: Using Scilab, simulate the motion of a simple pendulum with a given length and initial displacement. Plot the displacement versus time graph for the pendulum motion.

(OR)

Question 4: Derive the equations governing projectile motion. Discuss the factors affecting the range and maximum height of a projectile.

Question 5: Explain the concept of electrical circuits using Scilab. Provide an example of a circuit and its simulation using Scilab.

(OR)

Question 6: Simulate the behavior of a simple electrical circuit using Scilab. Plot voltage and current graphs for the circuit.

Section C: Light, Lasers, and Optical Fibres (M3-LLO)

Question 7: Explain the principle of operation of an optical fiber. Discuss the advantages of optical fibers over traditional copper wires in communication systems.

(OR)

Question 8: Describe the working principle of a laser. Discuss the process of stimulated emission and how it leads to the amplification of light in a laser cavity.

Question 9: Discuss the phenomenon of total internal reflection. Explain its significance in optical fiber communication.

(OR)

Question 10: Explain the concept of fiber optic sensors. Discuss their applications in various fields.

Section D: Semiconductor Devices and Optoelectronic Devices (M4-SOD)

Question 11: Discuss the working principle of a photovoltaic cell. Explain the process of photogeneration of electron-hole pairs and the generation of electrical energy in a photovoltaic cell.

(OR)

Question 12: Explain the concept of optoelectronic devices. Discuss the applications of optoelectronic devices in areas such as communication, sensing, and lighting.

Question 13: Describe the working principle of a light-emitting diode (LED). Discuss the advantages of LEDs over traditional incandescent bulbs.

(OR)

Question 14: Discuss the operation of a photodiode. Explain its applications in optoelectronic devices and its advantages over other photodetectors.

Section E: Number Systems, Logic Gates, and Logic Design (M5-NGD)

Question 15: Convert the following binary number into its hexadecimal and octal equivalents:
110110102110110102.

(OR)

Question 16: Design a logic circuit that implements the Boolean expression $F=A'BC+AB'C'+ABC$. Draw the circuit diagram and simplify the expression using Boolean algebra.

Question 17: Explain the concept of logic gates. Discuss the different types of logic gates and their truth tables.

(OR)

Question 18: Design a combinational logic circuit to implement a 2-bit binary to Gray code converter.

Section F: Waves and Oscillations, Crystal Structure, and Diffraction (M6-WCD)

Question 19: Discuss the concept of crystal structure in solids. Explain the difference between crystalline and amorphous solids, and give examples of each.

(OR)

Question 20: Explain the phenomenon of diffraction of waves. Describe how the diffraction pattern is formed when light passes through a single slit and when it passes through a double slit.

Question 21: Explain the concept of wave-particle duality. Discuss the implications of wave-particle duality in quantum mechanics.

(OR)

Question 22: Describe the properties and behavior of waves in different mediums. Discuss the applications of waves in various fields.

Section G: Quantum Mechanics and Quantum Gates (M7-QMG)

Question 23: Explain the postulates of quantum mechanics. Discuss the concept of superposition and how it is utilized in quantum computing.

(OR)

Question 24: Describe the basic principles of quantum gates. Explain how quantum gates manipulate qubits to perform quantum computations.

Question 25: Discuss the concept of quantum entanglement. Explain its significance in quantum computing and communication.

(OR)

Question 26: Explain the working principle of a quantum computer. Discuss its advantages over classical computers and potential applications.

Section H: Advanced Bulk materials and Nano materials (M8-ANM)

Question 27: Discuss the properties and applications of carbon nanotubes. Explain how the unique structure of carbon nanotubes leads to their exceptional mechanical, electrical, and thermal properties.

(OR)

Question 28: Explain the concept of nanomaterials. Discuss the applications of nanomaterials in fields such as medicine, electronics, and energy storage.

Question 29: Describe the synthesis methods of advanced bulk materials. Discuss their properties and potential applications.

(OR)

Question 30: Explain the properties and applications of graphene. Discuss its potential impact on various industries and future technological advancements.