INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**WAVES AND OPTICS**				
Course Code	AHSB04				
Programme	B.Tech				
Semester	I	AE | ECE | ME			
	II	EEE | CE			
Course Type	Foundation				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	1.5
Chief Coordinator	Dr. P Koteswara Rao, Associate Professor				
Course Faculty	Dr. Rizwana, Professor Dr. B Pratima, Associate Professor Ms. S Charvani, Associate Professor Mr. A Prakash, Assistant Professor Mr. K Saibaba, Assistant Professor Mr. T Srikanth, Assistant Professor				

I . COURSEOVERVIEW:

The course matter is divided into five modules covering duly-recognized areas of theory and study. This course develops abstract and critical reasoning by studying mathematical and logical proofs andassumptions as applied in basic physics and to make connections between physics and other branches of sciences and technology. The topics covered include waves, non-dispersive transverse and longitudinal waves, light and optics, wave optics, lasers, introduction to quantum mechanics, solution of wave equation and introduction to solids and semiconductors. The course helps students to gain knowledge of basic principles and appreciate the diverse applications in technological fields in respectivebranches.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic principles of light waves

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIAExamination	Total Marks
Waves and Optics	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

VI. HOW PROGRAM OUTCOMES AREASSESSED:

	Program Outcomes (POs)	Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complexengineering problems.	3	Presentation on real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Term paper
PO 4	**Conduct investigations of complex problems**: Use research- based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesisof the information to provide valid conclusions.	1	Seminar

3= High; 2 = Medium; 1 = Low

V11. HOW PROGRAM SPECIFIC OUTCOMES AREASSESSED:

	Program Specific Outcomes (PSOs)	Strength	Proficiency assessed by
PSO 1	**Professional skills**: Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development ofnew products.	-	-
PSO 2	**Professional skills**: Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles.	-	-
PSO 3	**Practical implementation and testing skills**: Providing different types of in house and training and industry practice to fabricate and test and develop the products.	2	Seminar
PSO 4	**Successful career and entrepreneurship**: To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and alliedsystems and become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

V111. COURSE OBJECTIVES:

The course should enable the students to:	
I	Enrich knowledge in principles of quantum mechanics and semiconductors.
II	Correlate principles and applications of lasers and fiber optics.
III	Meliorate the knowledge of light and optics and also their applications.
IV	Develop strong fundamentals of transverse, longitudinal waves and harmonic waves.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Student solves the time-independent Schrodinger equation as an intermediate step to solve the time-dependent Schrodinger equation and Student applies boundary conditions to constraint the set of possible states.	CLO 1	Recall the basic principles of physics and apply these concepts of physics in solving thereal-time problems.
		CLO 2	Acquire knowledge about fundamental in quantum mechanics.
		CLO 3	Interpretation of dual nature of matter wave concept using Davisson & Germer'sexperiment
CO2	Understand the motion of electrons in microscopic level and knowledge on semiconductors and its applications.	CLO 4	Estimate the energy of the particles using Schrödinger's wave equation and apply it to particle in potential box.
		CLO 5	Recollect the conductivity mechanism involved in semiconductors and calculate carrier concentrations.
		CLO 6	Understand the band structure of a solid and Classify materials as metals**,** insulators, or semiconductors, and sketch a schematic band diagram for each one.
CO3	Production of laser and their applications Student will understand	CLO 7	Understand the basic principles involved in the production of Laser light and also real-time applications of lasers.

COs	Course Outcome	CLOs	Course Learning Outcome
	the working principle of optical fibers and their usage in real time.	CLO 8	Recollect basic principle, construction, types and attenuation of optical fibers.
		CLO 9	Understand the importance of optical fibers in real-time communication system.
CO4	Optics is the branch of physics which includes the study of light and the phenomena associated with its generation, transmission & detection.	CLO 10	Apply different laws of radiation tounderstand the phenomenon behind production of light.
		CLO 11	Apply the phenomenon of interference inthin films using Newton's rings experiment.
		CLO 12	Identify diffraction phenomenon due to slits.
CO5	To understanding of laws of oscillations.	CLO 13	Acquire knowledge of basic harmonic oscillators and discuss in detail different types of harmonic oscillators.
		CLO 14	Describe the steady state motion of forceddamped harmonic oscillator.
		CLO 15	Acquire knowledge of reflection and transmission of waves at a boundary of media.

X. COURSE LEARNING OUTCOMES(CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHSB04.01	CLO 1	Recall the basic principles of physics and apply these concepts of physics in solving the real-time problems.	PO 1, PO2	3
AHSB04.02	CLO 2	Acquire knowledge about fundamental in quantum mechanics.	PO 1, PO2	3
AHSB04.03	CLO 3	Interpretation of dual nature of matter wave concept using Davisson & Germer'sexperiment.	PO1, PO 4	3
AHSB04.04	CLO 4	Estimate the energy of the particles using Schrödinger's wave equation and apply it to particle in potential box.	PO 2, PO4	2
AHSB04.05	CLO 5	Recollect the conductivity mechanism involved in semiconductors and calculate carrier concentrations.	PO 1	3
AHSB04.06	CLO 6	Understand the band structure of a solid and Classify materials as metals, insulators, or semiconductors, and sketch a schematic band diagram for each one.	PO 2, PO4	2
AHSB04.07	CLO 7	Understand the basic principles involved in the production of Laser light and also real-time applications of lasers.	PO 1, PO2	3
AHSB04.08	CLO 8	Recollect basic principle, construction, types and attenuation of optical fibers.	PO 1, PO4	3
AHSB04.09	CLO 9	Understand the importance of optical fibers in real-time communication system.	PO2, PO4	2
AHSB04.10	CLO 10	Apply different laws of radiation to understand the phenomenon behind production of light.	PO 1, PO4	3
AHSB04.11	CLO 11	Apply the phenomenon of interference in thin films using Newton's rings experiment.	PO 1	3
AHSB04.12	CLO 12	Identify diffraction phenomenon due to slits.	PO 1, PO2	3
AHSB04.13	CLO 13	Acquire knowledge of basic harmonic oscillators and discuss in detail different types of harmonic oscillators.	PO2, PO4	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHSB04.14	CLO 14	Describe the steady state motion of forced damped harmonic oscillator.	PO 1, PO4	2
AHSB04.15	CLO 15	Acquire knowledge of reflection and transmission of waves at a boundary ofmedia.	PO 1 PO2	3

3= High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcomes (COs)	Program Outcomes (POs)			Program Specific outcomes (PSOs)
	PO 1	PO 2	PO 4	PSO2
CO 1	3	2		1
CO 2		2	1	
CO 3	3	2		1
CO 4	3	2		1
CO 5	3			

XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3	2													2	
CLO 2	3	2														
CLO 3	3			1												
CLO 4		2		1											1	
CLO 5	3															
CLO 6		2		1												
CLO 7	3	2														
CLO 8	3			1											2	
CLO 9		2		1											1	
CLO 10	3			1												
CLO 11	3															
CLO 12	3	2														
CLO 13		2		1												

CLO 14	3			1												
CLO 15	3	2														

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO1, PO2, PO4,PSO2	SEE Exams	PO1, PO2, PO4,PSO1	Assignments	-	Seminars	PO1, PO2, PO4,PSO2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1, PO2, PO4,PSO2						

XIV. ASSESSMENT METHODOLOGIES -INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

Module-I	**QUANTUM MECHANICS**
Introduction to quantum physics, Black body radiation, Planck's law, Photoelectric effect, Compton effect, De-Broglie's hypothesis, Wave-particle duality, Davisson and Germer experiment, Time-independent Schrodinger equation for wave function, Born interpretation of the wave function, Schrodinger equation for one dimensional problems–particle in a box.	
Module-II	**INTRODUCTION TO SOLIDS AND SEMICONDUCTORS**
Bloch's theorem for particles in a periodic potential, Kronig-Penney model (Qualitative treatment), Origin of energy bands. Types of electronic materials: metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, Carrier concentration, Dependence of Fermi level on carrier-concentration and temperature, Carrier generation and recombination, Hall effect.	
Module-III	**LASERS AND FIBER OPTICS**
Characteristics of lasers, Spontaneous and stimulated emission of radiation, Metastable state, Population inversion, Lasing action, Ruby laser, He-Ne laser and applications of lasers. Principle and construction of an optical fiber, Acceptance angle, Numerical aperture, Types of optical fibers (Single mode, multimode, step index, graded index), Attenuation in optical fibers, Optical fiber communication system with block diagram.	
Module-IV	**LIGHT AND OPTICS**
Huygens' principle, Superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer. Fraunhofer diffraction from a single slit, circular aperture and diffraction grating.	
Module-V	**HARMONIC OSCILLATIONS AND WAVES IN ONE DIMENSION**
Mechanical and electrical simple harmonic oscillators, Damped harmonic oscillator, Forced mechanical and electrical oscillators, Impedance, Steady state motion of forced damped harmonic oscillator. Transverse wave on a string, the wave equation on a string, Harmonic waves, Reflection and transmission of waves at a boundary, Longitudinal waves and the wave equation for them, acoustics waves.	
Text Books:	
Dr. K. Vijaya Kumar, Dr. S. Chandralingam, "Modern Engineering Physics", Chand & Co. New Delhi, 1st Edition, 2010. I. G. Main, "Vibrations and waves in physics", Cambridge University Press, 1993. R. K. Gaur, S. L. Gupta, "Engineering Physics", Dhanpat Rai Publications, 8th Edition, 2001.	

Reference Books:
H.J. Pain, "The physics of vibrations and waves", Wiley, 2006. A. Ghatak, "Optics", McGraw Hill Education, 2012. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.

XVI. COURSEPLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No.	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Introduction to quantum physics	CLO 1	T2:5.5 R1:1.12.1
2	Black body radiation	CLO 1	T2:5.6 R1:1.12.3
3	Planck's law, Photoelectric effect, Compton effect	CLO 1	T2:5.10 R1:1.15
4	De-Broglie's hypothesis, Wave-particle duality	CLO 3	T2:5.15 R1:1.16
5	Davisson and Germer experiment	CLO 3	T2:5.17 R1:1.13.1
6	Time-independent Schrodinger equation for wave function	CLO 3	T2:5.18 R1:1.13.2
7	Born interpretation of the wave function	CLO 3	T2:5.19 R1:1.13.3
8	Schrodinger equationforone dimensional problems–particle in a box.	CLO 4	T2:5.20 R1:1.17.1
9	Bloch's theorem for particles in a periodic potential, Kronig-Penney model (Qualitative treatment)	CLO 6	T2:5.24 R1:1.17.3
10	Kronig-Penney model (Qualitative treatment)	CLO 6	T2:6.1 R1:2.3
11	Origin of energy bands	CLO 6	T2:6.3 R1:2.6.1
12	Types of electronic materials: metals, semiconductors, and insulators	CLO 6	T2:6.5 R1:2.6.2
13	Intrinsic semiconductors Carrier concentration	CLO 5	T2:7.3 R1:2.8
14	Intrinsic semiconductors Carrier concentration	CLO 5	T2:7.5,7.6 R1:2.9.2
15	Extrinsic semiconductors, Carrier concentration	CLO 5	T2:7.7 R1:2.10
16	Extrinsic semiconductors, Carrier concentration	CLO 5	T2:7.7 R1:2.10
17	Dependence of Fermi level on carrier-concentration and temperature	CLO 5	T2:7.11 R1:2.10.2
18	Carrier generation and recombination, Hall effect	CLO 5	T2:7.11 R1:2.32
19	Introduction and Characteristics of lasers	CLO 7	T2:15. R1:8.2
20	Spontaneous and stimulated emission of radiation	CLO 7	T2:15.7 R1:8.3.3
21	Metastable state, Population inversion, Lasing action	CLO 7	T2:15.13 R1:8.7.2
22	Ruby laser	CLO 7	T2:15.13 R1:8.7.2
23	He-Ne laser and applications of lasers	CLO 7	T2:15.16 R1:8.7.3
24	Introduction and Principle and construction of an optical fiber	CLO 8	T1:11.9 R2:12.24

Lecture No.	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
25	Acceptance angle, Numerical aperture	CLO 8	T1:11.9 R3:12.25
26	Types of optical fibers (Single mode, multimode, step index, graded index)	CLO 8	T1:3.2 R3:3.2
27	Attenuation in optical fibers	CLO 9	T1:3.3.1 R3:3.2
28	Optical fiber communication system with block diagram.	CLO 9	T2:16.5 R1:8.10
29	Huygens' principle, Superposition of waves	CLO 10	T2:16.9 R1:8.11.1
30	Interference of light by wave front splitting and amplitude splitting;	CLO 10	T2:16.9 R1:8.11.2
31	Young's double slit experiment	CLO 10	T2:16.8 R1:8.12.1
32	Newton's rings	CLO 10	T2:16.8 R1:8.12.2
33	Michelson interferometer	CLO 10	T2:16.1 R1:8.14
34	Fraunhofer diffraction from a single slit	CLO 11	T2:16.11 R1:8.20
35	Circular aperture and diffraction grating	CLO 11	T2:16.12 R1:8.19
36	Introduction and Mechanical and electrical simple harmonic oscillators	CLO 13	T2:16.12 R1:8.77
37	Damped harmonic oscillator	CLO 13	T2:1.2 R1:7.2
38	Forced mechanical and electrical oscillators	CLO 13	T2:1.16 R1:7.7
39	Impedance, Steady state motion of forced damped harmonic oscillator	CLO 13	T2:1.20 R1:7.8
40	Impedance, Steady state motion of forced damped harmonic oscillator	CLO 13	T2:1.20 R1:7.8
41	Transverse wave on a string, the wave equation on astring	CLO 14	T2:2.1 R1:7.9.2
42	Harmonic waves	CLO 14	T2:2.2 R1:7.9.1
43	Reflection and transmission of waves at a boundary	CLO 14	T2:2.3 R1:7.10
44	Longitudinal waves and the wave equation for them	CLO 15	T2:2.4 R1:7.11
45	Acoustics waves	CLO 15	T2:2.5 R1:7.11.1

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSIONREQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Encourage the students to design the working models which are correlated with the syllabus.	Seminars / Laboratory Practices	PO 1	PSO 2
2	Insist the students to collect real-time applications of the basic principles they learn in physics.	Seminars / NPTEL	PO 2	PSO 2
3	Motivate the students to organise the seminars for the awareness of Upcoming applications in physics.	NPTEL	PO 2	PSO 2

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