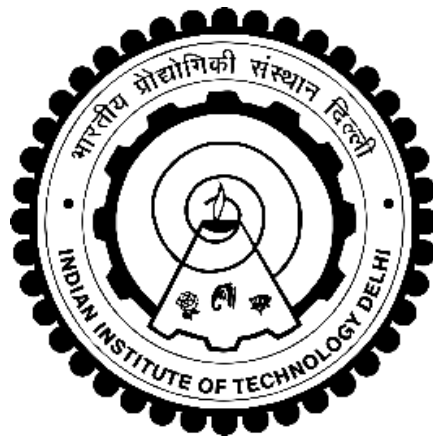


Syllabus

Master of Technology Programme Applied Optics



**INDIAN INSTITUTE OF TECHNOLOGY DELHI
NEW DELHI – 110016. INDIA**

May 2015

M.Tech (Applied Optics)

Overall credit structure

Program Core (PC)	Elective (PE+OE)	Total Credits
39 (includes project:18 Cr)	12 (9+3)	51

Semester I

C.No.	Course	Type	L-T-P	Credits
PYL755	Basic optics and optical instrumentation	PC	3-0-0	3
PYL751	Optical sources, photometry and metrology	PC	3-0-0	3
PYL753	Optical systems design	PC	3-0-0	3
PYP761	Optical fabrication and metrology laboratory	PC	0-0-6	3
	Elective-I	PE	3-0-0	3
	Semester total		12-0-6	15

Programming as audit level course for all students in the first semester is recommended.

Semester II

C.No.	Course	Type	L-T-P	Credits
PYL752	Laser systems and applications	PC	3-0-0	3
PYL756	Fourier optics and holography	PC	3-0-0	3
PYP762	Advanced optics laboratory	PC	0-0-6	3
	Elective-II	PE	3-0-0	3
	Elective III	PE	3-0-0	3
	Semester total		12-0-6	15

Semester III

S.No.	Course	Type	L-T-P	Credits
1	Elective IV (Open elective)	OE	3-0-0	3
PHD851	Major Project Part-I	PC	0-0-12	6
	Semester total		6-0-12	9

Semester IV

Course	Title	Type	L-T-P	Credits
PHD852	Major Project Part-II	PC	0-0-24	12
	Total Credits		0-0-24	12

Suggested Program elective courses

Course	Title	Type	L-T-P	Credits
PYL757	Statistical and Quantum optics	PE	3-0-0	3
PYL758	Advanced Quantum optics and applications	PE	3-0-0	3
PYL759	Computational optical imaging	PE	3-0-0	3
PYL760	Biomedical optics and Bio-photonics	PE	3-0-0	3
PYP763	Computational Optics laboratory	PE	0-0-6	3
PYP764	Advanced Optical Workshop	PE	0-0-6	3
PYL770	Ultra-fast optics and applications	PE	3-0-0	3
PYL771	Green Photonics	PE	3-0-0	3
PYL772	Plasmonic sensors	PE	3-0-0	3
PYL780	Diffraction and micro optics	PE	3-0-0	3
PYL858	Advanced Holographic techniques	PE	3-0-0	3
PYL879	Selected Topics in Applied Optics	PE	3-0-0	3
PYL881	Selected Topics – I	PHV	1-0-0	1
PYL882	Selected Topics – II	PHV	1-0-0	1
PYL883	Minor Project	PE	0-0-6	3
PYL791	Fiber Optics	PE	3-0-0	3
PYL792	Optical Electronics	PE	3-0-0	3
PYL795	Optics and Lasers	PE	3-0-0	3
PYL891	Guided Wave Photonic Sensors	PE	3-0-0	3
PHS855	Independent Study	PE	0-3-0	3

Courses arranged number-wise

Course	Title	Type	L-T-P	Credits
PYL751	Optical sources, photometry and metrology	PC	3-0-0	3
PYL752	Laser systems and applications	PC	3-0-0	3
PYL753	Optical systems design	PC	3-0-0	3
PYL755	Basic optics and optical instrumentation	PC	3-0-0	3
PYL756	Fourier optics and holography	PC	3-0-0	3
PYL757	Statistical and Quantum optics	PE	3-0-0	3
PYL758	Advanced Quantum optics and applications	PE	3-0-0	3
PYL759	Computational optical imaging	PE	3-0-0	3
PYL760	Biomedical optics and Bio-photonics	PE	3-0-0	3
PYP761	Optical fabrication and metrology laboratory	PC	0-0-6	3
PYP762	Advanced optics laboratory	PC	0-0-6	3
PYP763	Computational Optics laboratory	PE	0-0-6	3
PYP764	Advanced Optical Workshop	PE	0-0-6	3
PYL770	Ultra-fast optics and applications	PE	3-0-0	3
PYL771	Green Photonics	PE	3-0-0	3
PYL772	Plasmonic sensors	PE	3-0-0	3
PYL780	Diffraction and micro optics	PE	3-0-0	3
PYL858	Advanced Holographic techniques	PE	3-0-0	3
PHD851	Major Project Part-I	PC	0-0-12	6
PHD852	Major Project Part-II	PC	0-0-24	12
PYL879	Selected Topics in Applied Optics	PE	3-0-0	3
PYL881	Selected Topics – I	PHV	1-0-0	1
PYL882	Selected Topics – II	PHV	1-0-0	1
PYL883	Minor Project	PE	0-0-6	3
PYL791	Fiber Optics	PE	3-0-0	3
PYL792	Optical Electronics	PE	3-0-0	3
PYL795	Optics and Lasers	PE	3-0-0	3
PYL891	Guided Wave Photonic Sensors	PE	3-0-0	3
PHS855	Independent Study	PE	0-3-0	3

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	ADVANCED OPTICS LABORATORY	
3.	L-T-P structure	0 - 0 - 6	
4.	Credits	3	
5.	Course number	PYP762	
6.	Status (<i>category for program</i>)	Programme Core	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course Aloka Sinha, P.Senthilkumaran, Joby Joseph, DSMehta, Kedar Khare		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): This laboratory introduces the students to advanced level experiments in optics in the area of holography, speckles, Fourier Optics and Nonlinear Optics. Some experiments related to current areas of research in optics are also incorporated.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Experiments related to recording and development of holograms, Laser Speckles, Fresnel hologram, Reflection and Rainbow hologram, Polarization, Spatial filtering, Digital holography, Optical security systems, Optical singularity, Nonlinear optical processes, Tomography.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
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COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Polarizing microscope and strain viewer	08
2	Measurement of In-plane and out of plane displacement by using double exposure speckle photography and point-wise / whole field filtering	09
3	3D shape measurement by fringe projection profilometry	08
4	Study of spatial filtering	09
5	Recording and reconstruction of (i) Fresnel (ii) Digital holograms	12
6	Verification of Sampling theorem	06
7	Study of optical security systems (image/data encryption)	08
8	Optical phase singularity	08
9	Frequency domain Optical coherence tomography	08
10	Fiber optic dual beam optical trapping	08
COURSE TOTAL (14 times 'P')		84

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

RS Sirohi, Optical methods of measurement, CRC press, Taylor and Francis group.
 E.Hecht, Optics, Addison Wesley; 4th Edition, 2001.
 P.Hariharan, Optical Holography Principles, techniques and applications, Cambridge Univ. Press, 2nd Edition, 1996.
 D.Malacara, Optical Shop Testing, Wiley, 3rd Edition, 2007
 J.W.Goodman, Introduction to Fourier Optics, Second Edition, Mc Graw Hill, 1996.
 Specific hand outs and research papers are also provided.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	MatLab
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	Laboratory with dark room for recording and development of holograms, optical benches, vibration isolation tables
19.5	Equipment	Polarizing microscope, Cameras, Photographic plates, Spatial filtering arrangement, Spatial light modulator, Optical fibers, Optical sources, Diffractive optical elements, Projection systems, FD OCT systems and software, RGB laser, projector, computers
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	20%
20.2	Open-ended problems	10%
20.3	Project-type activity	40%
20.4	Open-ended laboratory work	30%
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	BASIC OPTICS AND OPTICAL INSTRUMENTATION	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	PYL755	
6.	Status (<i>category for program</i>)	Programme Core	

7.	Pre-requisites (course no./title)	NIL	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	PYL795 (20%), PHL558 (10%), IDL731(5%)	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course Prof. Anurag Sharma, Prof. P.Senthilkumaran, Dr.Kedar Khare, Prof. Joby Joseph		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): This is a basic course in optical sciences and engineering. Students are exposed to basic optics and instruments.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Reflection and refraction of plane waves and by spherical surfaces; Lens aberrations; Polarization and Polarizing components; Diffraction: diffraction by single and multiple slits and circular aperture, Gaussian beams, Interference: two beam and multiple beam interference. Inteferometers: Shearing and Scanning interferometers, interferometric instrumentation for testing, Polarization interferometers; Spectroscopic instrumentation, Fourier transform spectroscopy; Imaging and super resolution imaging, near-field imaging techniques; Adaptive optics; Wavefront sensing and correction,reconstruction, Opto-medical instruments; optical coherence		
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	tomography, Infrared instrumentation; I.R. telescopes, focal plane arrays; Light field camera, Space optics; Satellite cameras, high-resolution radiometers, space telescopes, space based sensors;
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Reflection and refraction of plane waves and by spherical surfaces	4
2	Lens aberrations	3
3	Polarization and Polarizing components	4
4	Diffraction: diffraction by single and multiple slits and circular aperture, Gaussian beams	4
5	Interference: two beam and multiple beam interference	3
6	Interferometers: Shearing and Scanning interferometers, interferometric instrumentation for testing, Polarization interferometers	5
7	Spectroscopic instrumentation, Fourier transform spectroscopy	3
8	Imaging and super resolution imaging, near-field imaging techniques	4
9	Adaptive optics; Wavefront sensing and correction, reconstruction	3
10	Opto-medical instruments; optical coherence tomography, Infrared instrumentation	4
11	I.R. telescopes, focal plane arrays, Light field camera	2
12	Space optics; Satellite cameras, high-resolution radiometers, space telescopes, space based sensors	3
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

E.Hecht, Optics, 4th Edition, Pierson, 2002.
A.K.Ghatak, Optics, 5th Edition, Mc Graw Hill, 2014.
B.K.Johnson, Optics and Optical instruments, Dover Publications, 1967.
F.A.Jenkins and H.E.White, Fundamentals of Optics, 4th Edition, McGraw Hill, 1981.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Class room with projection facility
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	10%
20.2	Open-ended problems	
20.3	Project-type activity	10%
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics
2.	Course Title (<i>< 45 characters</i>)	FOURIER OPTICS AND HOLOGRAPHY
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL756
6.	Status (<i>category for program</i>)	Program Core

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. Senthilkumaran, Prof. Joby Joseph, Prof. Anurag Sharma, Dr. Kedar Khare	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): Information processing using optical techniques such as holography and Fourier transform is an important area of Modern Optics. In this course the fundamentals, techniques and applications of holography and Fourier optics will be provided.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Signals and systems, Fourier Transform(FT), Sampling theorem; Diffraction theory; Fresnel-Kirchhoff formulation and angular spectrum method, brief discussion of Fresnel and Fraunhofer diffraction, FT properties of lenses and image formation by a lens; Frequency response of a diffraction-limited system under coherent and incoherent illumination, OTF-effects of aberration and apodization, comparison of coherent and incoherent imaging, super-resolution; Techniques for measurement of OTF; Analog optical information processing: Abbe-Porter experiment, phase contrast microscopy and other simple	
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	applications; Coherent image processing: VanderLugt filter; joint-transform correlator; pattern recognition, Synthetic Aperture Radar. Basics of holography, in-line and off-axis holography; transmission and reflection holograms, Amplitude and phase holograms, Recording materials. Thick and thin holograms
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Signals and systems, Fourier Transform(FT), Sampling theorem	4
2	Diffraction theory; Fresnel-Kirchhoff formulation and angular spectrum method	5
3	brief discussion of Fresnel and Fraunhofer diffraction,	4
4	FT properties of lenses and image formation by a lens;	4
5	Frequency response of a diffraction-limited system under coherent and incoherent illumination,	3
6	OTF-effects of aberration and apodization, comparison of coherent and incoherent imaging, super-resolution;	3
7	Techniques for measurement of OTF; Analog optical information processing:	3
8	Abbe-Porter experiment, phase contrast microscopy and other simple applications; Coherent image processing:	3
9	VanderLugt filter; joint-transform correlator; pattern recognition,	3
10	Synthetic Aperture Radar.	3
11	Basics of holography, in-line and off-axis holography;	3
12	Transmission and reflection holograms, Amplitude and phase holograms, Recording materials. Thick and thin holograms	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

J.W.Goodman, Introduction to Fourier Optics, Second Edition, Mc Graw Hill, 1996.
P.Hariharan, Optical Holography, Principles, Techniques and Applications, 2nd Edition, Cambridge Univ.Press, 1996.
R.N.Bracewell, The Fourier Transforms and its applications, 2nd Edition, Mc Graw Hill, 1965.
Gaskill.J., Linear systems, Fourier Transforms and optics, Wiley, 1978.
Denisyuk, Y. Fundamentals of Holography, MIR Publisher, Moscow, 1984.
R.J.Collier, An Optical holography, Academic Press, 1971.

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Class room with projection facility
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	LASER SYSTEMS AND APPLICATIONS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL - 752
6.	Status (<i>category for program</i>)	Programme Core

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	PYL795 (5%)
8.2	Overlap with any UG/PG course of other Dept./Centre	PHL655(10%)
8.3	Supercedes any existing course	

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. D. S. Mehta, Dr. Aloka Sinha, Prof. M. R. Shenoy, Dr. Amartya Sen Gupta, Dr. G. V. Prakash	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): Lasers and their applications have become integral part of our society. Today the laser systems have ubiquitous applications in almost all the areas. The objective is to develop understanding and experience about the various laser systems and their applications. To provide knowledge about basics principles, physics, system development and their applications.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Review of Laser theory, properties of laser radiation, and laser safety; CW lasers systems: Ruby-, Nd:YAG- and Nd:Glass lasers, DPSS lasers, fiber lasers, gas lasers, Pulsed lasers: ns, ps, and fs lasers, excimer-, dye-, X-ray- and free-electron lasers; Semiconductor lasers: DH, QW, QCL, VCSEL, DFB- and DBR lasers; Application of lasers in data storage, communication and information technology; Laser applications in optical metrology; Surface profile and dimensional measurements; Laser Applications in material processing and	
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	manufacturing; 3D-printing, marking, drilling, cutting, welding, hardening and manufacturing; Laser Doppler velocimetry, LIDAR, laser spectroscopy, LIF, LIBS, Bio-medical applications of lasers, Laser tweezers and applications, laser applications in defense.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Review of laser theory, properties of laser radiation, and laser safety.	5
2	CW-lasers: Solid state, gas, dye and fiber laser systems	5
3	Pulsed Lasers: ns, ps, and fs laser systems	5
4	Semiconductor lasers: double heterostructures, QW, Quantum Cascade, VECSEL, DFB and DBR lasers	6
5	Application of lasers in communication and information technology	3
6	Laser applications in material precessing and manufacturing	4
7	Laser Doppler velocimetry	3
8	Laser tweezers and applications	3
9	LIDAR, Laser spectroscopy, LIF, LIBS	3
10	Laser applications in defense	5
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
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5		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. W. T. Silfvast, Laser Fundamentals, Cambridge Univ. Press, Cambridge, 1996.
2. John F. Ready, Industrial Applications of Lasers, 2nd Edn., Academic Press, San Diego, 1997.
3. A. Roy Henderson, A Guide to Laser Safety, Chapman & Hall, London, 1997.
4. A. Yariv, Optical Electronics in Modern Communication, Oxford University Press 1997, 5th Ed.
5. C. C. Davis, Lasers and Electro-Optics, Cambridge Univ. Press, Cambridge, 1996.
6. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
7. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc. 1991.
8. A. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge Univ. Press, Cambridge, 1989.

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Class room with projection facility
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	OPTICAL FABRICATION AND METROLOGY LABORATORY
3.	L-T-P structure	0 - 0 - 6
4.	Credits	3
5.	Course number	PHP761
6.	Status (<i>category for program</i>)	Programme Core

7.	Pre-requisites (course no./title)	NIL
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	No

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof.D.S.Mehta, Dr.GUFRAN SAYEED KHAN (IDDC), Prof.JobyJoseph	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): The laboratory provides the understanding of various fabrication processes involved in developing an optical elements . The course involves hand on experience on development of optical elements. Students are asked to make the optics with the desired dimensions. Emphasis is placed on the selection and use of tooling, materials and equipment used in the manufacturing process. The metrology laboratory focusses on practical measurement techniques for optical surfaces, components and systems while comparing the measurement results with the specifications relating to fabrication issues.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Trepanning, Grinding, Curve generation, smoothing and polishing, Centering and Edging, optical coating, Autocollimator, Newton interferometer, Twyman-Green interferometer, Shack Hartmann Sensor and Moire, and Talbot interferometry for measurement of optical performance parameters of the	
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	optical elements.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1		
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12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Fabrication of an optical element such as planoconvex, biconvex lens and optical flats. The process involves trepanning, grinding, roughing.	09
2	Smoothing and deterministic polishing of optical element developed in the the grinding process + Newton and Fizeau Interferometer for Testing of optical surface	15
3	Quantitative testing of optical elements using polarisation based Twyman-Green interferometer	09
4	Centering and Edging of an optical element such as biconvex lens	09
5	Wavefront measurement by Shack Hartmann Sensor	06
6	Masurement of wedge angle of optical flat and right angle of a prism by Autocollimation	06
7	Measurement of Radius of curvature of curved surfaces by using Hilger spherometer and a microscope.	06
8	Measurement of refractive indices of liquids by using Abbe refractometer.	06
9	White light interferometry for the determination thickness and refractive index	09
10	Fabry - Perot and Michelson interferometer	09
COURSE TOTAL (14 times 'P')		84

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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| <ol style="list-style-type: none"> 1. Karow H.H, Fabrication methods for precision optics, John Wiley & Sons Inc., 1993 2. Hradyanath, R., Optical Workshop Technology, Tata McGraw-Hill, 1993 3. Horne, D.F, Optical Production Technology, 1983 4. Malacara, D, Optical Shop Testing, Third Edition, John Wiley & Sons Inc., 2007 5. B.K.Johnson, Optics and Optical instruments, Dovers Publications Inc., 1960. |
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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	Applied Optics Lab, Physics Dept. Optical Workshop, IDDC Optical Metrology Lab, IDDC
19.5	Equipment	Trapanning, Curve generating machine, roughing, smoothing, polishing, cenring/Edging machines, SH Sensor Assembly, Autocollimator, Spherometers, Refractometers, Fabry-Perot interferometer, Michelson interferometers, Optical sources, detectors, PZT phase shifter for white light interference microscope, Spectrometer and accessories.
19.6	Classroom infrastructure	
19.7	Site visits	One industrial visit: probable sites are IRDE Dehradun, CSIO Chandigarh

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	20%
20.2	Open-ended problems	
20.3	Project-type activity	50%
20.4	Open-ended laboratory work	30%
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics
2.	Course Title (<i>< 45 characters</i>)	OPTICAL SOURCES, PHOTOMETRY AND METROLOGY
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL751
6.	Status (<i>category for program</i>)	Program Core

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	PYL793 (5%)
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supercedes any existing course	

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. Joby Joseph, Prof. Anurag Sharma, Prof. D.S. Mehta, Dr. Kedar Khare	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): This course prepares the students to have basic ideas in light engineering, and standards. Students are also exposed to optical sources, detector and measurement of various physical parameters using optical techniques.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Eye and vision: Visual system, sensitivity, acuity; Radiometry and Photmetry: Radiometric quantities and their measurements, Photmetric quantities, Radiation from a surface; Brightness and luminous intensity distribution; Integrating sphere; Illumination from a line, surface and volume sources; Colorimetry: Fundamentals, trichromatic specifications, Colorimeters, CIE system; Conventional light sources: Point and extended sources; Incandescent, fluorescent, discharge lamps; LEDs; Lighting fundamentals, Optical detectors; Detector characteristics, Noise considerations, single & multi-element detectors, CCDs. Optical metrology: Surface inspection, optical gauging and profiling,	
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	Techniques for non-destructive testing, Moire self imaging and speckle metrology, Sensing elements
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Eye and vision: Visual system, sensitivity, acuity	3
2	Radiometry and Photometry: Radiometric quantities and their measurements, Photometric quantities	3
3	Radiation from a surface; Brightness and luminous intensity distribution; Integrating sphere	4
4	Illumination from a line, surface and volume sources	4
5	Colorimetry: Fundamentals, trichromatic specifications, Colorimeters, CIE system	4
6	Conventional light sources: Point and extended sources; Incandescent, fluorescent, discharge lamps; LEDs	5
7	Lighting fundamentals	4
8	Optical detectors; Detector characteristics, Noise considerations, single & multi-element detectors, CCDs	4
9	Optical metrology: Surface inspection, optical gauging and profiling	3
10	Techniques for non-destructive testing,	3
11	Moire self imaging and speckle metrology	3
12	Sensing elements	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Malacara, D, Optical Shop Testing, Third Edition, John Wiley & Sons Inc., 2007
 Optical Sources, Detectors, and Systems by Robert H. Kingston, Academic Press, 1995
 Photometry, by J.W.T. Walsh, Dover Publications, 1965
 Optical Metrology, by Kjell J. Gåsvik, Wiley (3rd ed.) 2002

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
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5		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Class room with projection facility
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	OPTICAL SYSTEMS DESIGN
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL753
6.	Status (<i>category for program</i>)	Programme Core

7.	Pre-requisites (course no./title)	None
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof. Anurag Sharma and Prof. B.D. Gupta	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): The purpose of the course is to train the students for designing an optical system for better quality image of an object.
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Gaussian theory of optical system; Aberrations: Transverse ray and wave aberrations; Chromatic aberration; Third order aberrations; Position and shape factors; Meridional ray tracing; Paraxial rays and first order optics; Primary chromatic aberration: Achromat doublet, Triplet and dialyte, tolerances, Chromatic aberration at finite aperture; Spherical aberration: surface contribution formulas; Spherically corrected achromat; Oblique pencils : Tracings of oblique meridional and skew rays; Coma and sine condition; Image evaluation: Geometric OTF, Strehl ratio, spot diagram; definition of merit function; Cooks Triplet and its derivatives; Double Gauss lens, Introduction to zoom lenses and aspherics, Examples of modern optical, GRIN optics.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Gaussian theory of optical system	4
2	Aberrations: Transverse ray and wave aberrations	2
3	Chromatic aberration	2
4	Third order aberrations; Position and shape factors; Image formation in the presence of monochromatic aberrations	5
5	The work of the lens designer; Meridional ray tracing: different methods	4
6	Paraxial rays and first order optics	3
7	Contribution of a single surface and a thin element to primary chromatic aberration: Achromat doublet, Triplet and dialyte, Chromatic aberration tolerances, Chromatic aberration at finite aperture	4
8	Spherical aberration: surface contribution formulas	4
9	Design of a spherically corrected achromat	2
10	Oblique pencils : Tracings of oblique meridional and skew rays; Coma and sine condition	4
11	Image evaluation: Geometric OTF, its computation and measurement, Strehl ratio, spot diagram; definition of merit function	4
12	Cooke Triplet and its derivatives; Double Gauss lens, Introduction to zoom lenses and aspherics, Examples of modern optical, GRIN optics	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1.	W.T. Welford, Aberrations of the Symmetric Optical System, Academic Press, London (1974).
2.	R. Kingslake and R. B. Johnson, Lens Design Fundamentals, Academic Press, New York (2009).
3.	Warren J. Smith, Modern Optical Engineering: The Design of Optical Systems, McGraw-Hill, New York (1991).
4.	R.R. Shannon, The Art and Science of Optical Design, Cambridge University Press

(1997)

5. E.W. Marchand, Gradient-Index Optics, Academic Press, New York (1978)

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	ADVANCED HOLOGRAPHIC TECHNIQUES
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL858
6.	Status (<i>category for program</i>)	Programme Elective

7.	Pre-requisites (<i>course no./title</i>)	EPL443
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	PYL756(5%)
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Prof.P.Senthilkumaran, Prof.Joby Joseph, Prof. D.S.Mehta	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): Applications of holography in almost all the engineering fields have been introduced to students in this course.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Basic concepts in holography, Holographic displays and stereograms, Image holograms, White light, Rainbow holograms, Color holograms, Volume holograms, Diffraction efficiencies, Fourier Transform holograms, Pattern recognition, Correlators. Computer generated holography, Digital holography and its applications: Holographic interferometry, Holographic contouring, NDT of engineering objects, Optical testing, HOEs, Particle sizing, holographic Particle Image Velocimetry, Microscopy, Interferometry, Imaging through aberrated media, phase amplification by holography, Multifunction elements, diffusers, interconnects, couplers, scanners, Optical data storage, optical data processing, holographic solar concentrators, Associative memory	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Basic concepts in holography,	4
2	Holographic displays and stereograms,	3
3	Image holograms, White light, Rainbow holograms, Color holograms,	4
4	Volume holograms, Diffraction efficiencies of holograms,	4
5	Fourier Transform, Pattern recognition, Correlators.	6
6	Computer generated holography, Digital holography. Applications:	4
7	Holo-photoelasticity, Holographic interferometry, Holographic contouring, NDT of engineering objects, Optical testing, HOEs,	4
8	Particle sizing, holographic Particle Image Velocimetry,	3
9	Microscopy, Interferometry, Imaging through aberrated media, phase amplification by holography,	4
10	Multifunction elements, diffusers, interconnects, couplers, scanners,	3
11	Optical data storage, optical data processing, holographic solar concentrators, Associative memory	3
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

C.M.Vest, Holographic interferometry, 1st Edition, John Wiley and Sons, 1979
 J.W.Goodman, Introduction to Fourier Optics, Second Edition, Mc Graw Hill, 1996.
 P.Hariharan, Optical Holography, Principles, Techniques and Applications, 2nd Edition, Cambridge Univ.Press, 1996.

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Class room with projection facility
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	ADVANCED OPTICAL WORKSHOP
3.	L-T-P structure	0 - 0 - 6
4.	Credits	3
5.	Course number	PYP764
6.	Status (<i>category for program</i>)	Programme Elective

7.	Pre-requisites (course no./title)	NIL
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Dr. Gurfran Sayeed Khan (IDDC), Prof.D.S.Mehta	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): The course offers the challenges in developing metal optics, shearing plates for Shearing interferometers, and Total Internal Refection prisms with in the specified tolerance. Students are exposed to the development of optical elements like beam splitter and optical mirror by optical coating. Associated with the fabrication process, interferometric testing will also be done quantitatively. By using the metrology feedback the components will be developed within the required tolerance limit.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Development of metal optics, Fabrication of Total Internal Reflection Prisms, Measurement of thin coating, Fabrication of Shearing plate , Shearing interferometry, Talbot interferometry, Moire interferometry	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
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12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Development of metal optics for Infra red Imaging applications	12
2	Development of prisms for Total Internal Reflection applications in projection systems	15
3	Thickness measurement of optical coating by using Electro-optic sensors	09
4	Development of Shearing plate upto 50 arcsec wedge angle	12
5	Shearing interferometry for testing of optical elements	09
6	Development of beam splitter and optical mirror by optical coating	09
7	Talbot interferometry for focal length and shape measurement	09
8	Moire interferometry for radius of curvature, focal length and surface measurement	09
9		
10		
COURSE TOTAL (14 times 'P')		84

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Karow H.H, Fabrication methods for precision optics, John Wiley & Sons Inc., 1993
2. Hradyanath, R., Optical Workshop Technology, Tata McGraw-Hill, 1993
3. Horne, D.F, Optical Production Technology, 1983
4. Malacara, D, Optical Shop Testing, Third Edition, John Wiley & Sons Inc., 2007

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	

19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	Optical Workshop, IDDC Optical Metrology Lab, IDDC
19.5	Equipment	All the fabrication machines available in optical workshop, Optical coating Unit, Hilger Autocollimator
19.6	Classroom infrastructure	
19.7	Site visits	One industrial visit: probable sites are IRDE Dehradun, CSIO Chandigarh

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	20%
20.2	Open-ended problems	
20.3	Project-type activity	50%
20.4	Open-ended laboratory work	30%
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	ADVANCED QUANTUM OPTICS AND APPLICATIONS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL758
6.	Status (<i>category for program</i>)	Programme Elective

7.	Pre-requisites (<i>course no./title</i>)	STATISTICAL AND QUANTUM OPTICS
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	PYL755(10%), PHL555(5%)
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supercedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Joyee Ghosh, Kedar Khare, K. Thyagarajan	
12.	Will the course require any visiting faculty?	

13.	Course objective (<i>about 50 words</i>): This course will provide a modern understanding of light as a quantum phenomenon, and explore how quantum applications such as quantum communications and quantum sensing are developed using quantum light. Significantly, landmark experiments in Quantum Optics will be discussed along with topics like entangled and squeezed states of light, quantum memories, quantum communication and related advanced topics. It will give necessary background for understanding some contemporary experiments.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Quantization of the EM field, Quantum states of light, Detection of quantum light, coincidence-counting, phase-sensitive detection, quantum treatment of linear optics, Quantum light by non-linear optical processes, signatures of quantum behaviour, Landmark experiments in quantum optics, light-matter interaction, Quantum memories, Experimental quantum communications :	
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	Quantum teleportation, entanglement swapping, quantum repeaters
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Quantization of the electromagnetic field	2
2	Quantum states of light: single photons, coherent states, squeezed states, entangled states. Representations of quantum states of light.	2
3	Correlation Functions. Detection of quantum light: photon counting, coincidence counting, phase-sensitive detection.	2
4	Photodetection Techniques: APD, SPCM, etc.	3
5	Generation of quantum light by non-linear optical processes.	3
6	Squeezed states & applications	4
7	Behavior of quantum fields with linear optics. Quantum treatment of beamsplitter and interferometers.	2
8	Experimental signatures of quantum behaviour	3
9	Landmark experiments in Quantum Optics.	5
10	Interaction of light with atoms/ions/atomic ensembles: Laser cooling, BEC, Ion trapping, etc.	4
11	Coherence Population Trapping, Electromagnetically Induced Transparency, Photon echoes, etc. Quantum Memories	4
12	Quantum Information, Experimental quantum communications: Quantum teleportation, entanglement swapping, Quantum networks, quantum repeaters	8
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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2		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

L. Mandel and E. Wolf, Coherence and Quantum Optics, Cambridge Univ. Press 1995 M. O. Scully and S. Zubairy, Quantum Optics, Cambridge university Press, 1997 P. Lambropoulos and D. Petrosyan, Fundamentals of Quantum Optics and Quantum Information, Springer 2007 M. A. Nielson and I. L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press 2000 H-A. Bachor and T.C. Ralph, A Guide to Experiments in Quantum Optics, Wiley-VCH 2004
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Additional Relevant Journal Articles

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Department of Physics	
2.	Course Title (<i>< 45 characters</i>)	BIOMEDICAL OPTICS AND BIOPHOTONICS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	PYL - 760	
6.	Status (<i>category for program</i>)	New Course, Open Elective for students of all Departments/Centres	

7.	Pre-requisites (<i>course no./title</i>)	EPL-445, PHL 751,	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	IDL-736: 15%	
8.2	Overlap with any UG/PG course of other Dept./Centre	PHL-754: 5%	
8.3	Supercedes any existing course	No	

9.	Not allowed for (<i>indicate program names</i>)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course D. S. Mehta, K. Khare, Joby Joseph		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): Biomedical optics and Bio-photonics are the emerging areas of advanced photonics technologies which are important for non-contact, non-invasive imaging, sensing and diagnostics in biology and medicine. The objective is to develop understanding and experience about the BIOMEDICAL OPTICS AND BIOPHOTONICS their principles, imaging and instrumentation. To provide knowledge about various Biomedical optical and Bio-photonic Imaging Technnologies, Imaging and Image Processing Tools.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Light-tissue and biological cell interactions and light induced effects in Biological systems. Basic principles of optical imaging and spectroscopy systems. Principles of standard optical microscopy/fluorescence microscopy/ endoscopy and instrumentation. Confocal microscopy: Principles and Instrumentation and Applications. Two-Photon and Multi-photon Microscopy.		
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	Optical coherence tomography (OCT): Physics, Technology, Imaging Concepts and Applications. Photo-acoustic Tomography (PAT): Principles, Technology, Imaging Concepts and Applications. Optical Tweezers and it's applications in biology. Bio-medical applications of lasers: Laser Scissors, LASIK, Photo-dynamic Therapy. Quantitative phase microscopy: Principles and imaging concepts. Advanced spectroscopic techniques for biological sensing and diagnosis: Fluorescence spectroscopy, Raman Spectroscopy, SERS, diffuse reflectance spectroscopy. Imaging beyond diffraction limit: Spatial light interference microscopy, SLIM, STED, Near field Scanning Optical Microscopy, Nanoscopy. Image processing/recovery methods: Deconvolution/ deblurring, enhancement, segmentation, iterative approaches to phase retrieval.
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Light-tissue and light-biological cell interaction/Light induced effects in Biological systems.	2
2	Basic principles of optical imaging and spectroscopy systems	2
3	Principles of standard optical microscopy/fluorescence microscopy/endoscopy and instrumentation.	3
4	Confocal microscopy: Principles, instrumentation and applications.	3
5	Two-photon and Multi-photon microscopy	2
6	Optical coherence tomography (OCT): Technology, imaging concepts, Image Processing and Applications.	6
7	Photo-acoustic Tomography (PAT): Principles, Technology, Imaging Concepts and Applications.	4
8	Quantitative Phase Microscopic Techniques (QPMT): Principles and Applications.	4
9	Optical Tweezers and its applications in biology and Biomedical Applications of Lasers.	5
10	Advanced spectroscopic techniques for sensing and diagnostics.	3
11	Biomedical image processing/recovery methods: Deconvolution/ deblurring, enhancement, segmentation, iterative approaches to phase retrieval.	4
12	Imaging beyond diffraction limit: Spatial light interference microscopy, STED, NSOM and Nanoscopy.	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

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|---|
| i. Biomedical Photonics Handbook by Tuan Vo-Dinh, CRC Press, 2003.
ii. Introduction to Biophotonics by P.N. Prosad, John-Wiley 2003. |
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- iii. Optical Imaging and Microscopy, Peter Torok, Fu-jen Kao (Eds.), Springer 2003
- iv. Handbook of Optical Coherence Tomography, By Bouma and Fujimoto, 2002.
- v. Optical Coherence Tomography: Technology and Applications by Wolfgang Drexler and J.G. Fujimoto, Springer 2008
- vi. Optical Trapping and Manipulations by laser, Arthur Ashkin, 2006, World Scientific
- vii. Coherent Light Microscopy : Imaging and Quantitative Phase Analysis:
By Pietro Ferraro, Adam Wax, Zeev Zalevsky, Springer 2011.
- viii. Principles of optics, By Born and Wolf.
- ix. Biomedical Optics: Principles and Imaging, Lihong Wang and H. Wu, Wiley 2007

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	PC
19.3	Teaching aides (videos, etc.)	OHP, LCD Projectors
19.4	Laboratory	NIL
19.5	Equipment	NIL
19.6	Classroom infrastructure	OHP, LCD Projector
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	COMPUTATIONAL OPTICAL IMAGING
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL759
6.	Status (<i>category for program</i>)	Programme Elective

7.	Pre-requisites (course no./title)	PYL 756 Fourier Optics and Holography or equivalent
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supercedes any existing course	

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Kedar Khare, D. S. Mehta, P. Senthilkumaran, Joby Joseph	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): Optical imaging systems increasingly have a hybrid design where optical hardware and image recovery algorithms are combined to give superior imaging performance. The course is aimed at providing a thorough background of this emerging research area, so that, students are able to apply this knowledge to practical imaging systems relevant to basic research and industrial applications.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Revision of Fourier optics and basic concepts in optical imaging, mathematical preliminaries on inverse problems in imaging, compressive imaging, multi-view imaging systems, point-spread function engineering, phase retrieval, interferometric imaging methods such as digital holography and optical coherence tomography, imaging through turbulent media, super-resolution through structured illumination, correlation/ghost imaging.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Revision of Fourier Optics and basic concepts in optical imaging	4
2	Introduction to inverse problems in imaging	2
3	Direct Fourier based methods for image reconstruction	2
4	Iterative methods for image reconstruction	4
5	Introduction to Compressive imaging	2
6	Multi-view 3D imaging systems: integral imaging, lightfield imaging, Fourier Ptychography, X-ray tomography	6
7	PSF Engineering: Extended depth of field and rotating PSF for optical sectioning	4
8	Phase retrieval: Transport-of-intensity and iterative methods	4
9	Interferometric imaging: Digital holography and allied topics	6
10	Imaging through turbulent and/or scattering media	2
11	Structured illumination and super-resolution imaging	3
12	Optical correlation or ghost imaging	3
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

M. Bertero and P. Boccacci, Introduction to Inverse Problems in Imaging, IoP Press 1998
H. H. Barrett and K. J. Myers, Foundations of Imaging Science, Wiley, 2003
D. Brady, Optical Imaging and Spectroscopy, Wiley 2009
J. W. Goodman, Introduction to Fourier Optics, McGraw Hill 1996

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	MATLAB or equivalent
19.2	Hardware	

19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	LCD
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	COMPUTATIONAL OPTICS LABORATORY	
3.	L-T-P structure	0 - 0 - 6	
4.	Credits	3	
5.	Course number	PHP763	
6.	Status (<i>category for program</i>)	Programme Elective	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course Dr.Kedar Khare, Prof. Joby Joseph, Prof.P.Senthilkumaran.		
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12.	Will the course require any visiting faculty?		
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13.	Course objective (<i>about 50 words</i>): The course is aimed at providing students oppurtunity to conduct simulation of optics experiemnts using commercial as well as other softwares. This is in view of the fact that modern day research and technology in optics involves virtual experiments and simulations.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Ray tracing in optical systems with commercial software, Image handling in MatLab or similar enviroment for optics experiments, Simulation of Fresnal and Fraunhofer diffraction, Fourier transforms and applications in optics, Simulation of spatial filtering, matched filtering and pattern recognition, Simulation of Joint Transform and Vander Lugt correlators, Synthesis of computer generated hologram and optical reconstruction, Simulation of recording and reconstruction of digital holograms, Interferogram analysis using Fourier and Phase shifting methods, Stoke's parameters of optical beams and plotting of polarization ellipse, Simulation of multi-beam interference for photonic crystal		
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	designs, Simulation of multi-beam interference for photonic crystal designs, Design Project
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Ray tracing in optical systems with commercial software	07
2	Image handling in MatLab or similar environment for optics experiments	07
3	Fourier transforms and applications in optics	07
4	Simulation of Fresnel and Fraunhofer diffraction	07
5	Simulation of spatial filtering, matched filtering and pattern recognition	07
6	Simulation of Joint Transform and Vander Lugt correlators	07
7	Synthesis of computer generated hologram and optical reconstruction	07
8	Simulation of recording and reconstruction of digital holograms	07
9	Interferogram analysis using Fourier and Phase shifting methods	07
10	Stoke's parameters of optical beams and plotting of polarization ellipse	07
11	Simulation of multi-beam interference for photonic crystal designs	07
12	Design Project	07
COURSE TOTAL (14 times 'L')		84

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Research papers and hand outs provided.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	MatLab, Virtual Lab, Zemax, Photonic crystal software. Comsol EM Tool box,
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	Laboratory with computational facilities
19.5	Equipment	Spatial Light Modulators, Digital cameras, Stokes Camera

19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	DIFFRACTIVE AND MICRO OPTICS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL780
6.	Status (<i>category for program</i>)	Programme Elective

7.	Pre-requisites (course no./title)	NIL
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course	

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course P.SENTHILKUMARAN, GUFRAN SAYEED KHAN (IDDC), JOBY JOSEPH, D.S.MEHTA, ANURAG SHARMA	
12.	Will the course require any visiting faculty?	NO

13.	Course objective (<i>about 50 words</i>): The efficient optical instruments require optics with more degrees of freedom to meet greater demands in their performance. These instruments are composed of diffractive elements, off-axis aspheres and freeform surfaces. The use of these elements in an optical system provides opportunities for numerous improvements in the performance. In the last one decade there have been technological advances in precision optical technologies whereby new design, manufacturing and testing procedures for such optics are developed. There is a need for optical engineers to learn about these recent scientific and technological developments and aware about the challenges involved in incorporating such optics.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Diffractive optics, Micro optics, Design of diffractive optics, Amplitude and Phase Diffractive Optics, Application of Diffractive optics, Fabrication of	
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	Diffractive and micro optics, Photo-Lithography, Interferometric, profilometric and other testing techniques for Diffractive optics, Plastic optics, Injection Moulding of plastic optics, Applications of Micro optics in Beam shaping, MOEMS, Optical information technology and Aspheric optics, Freeform optics
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Diffractive and micro optics, Novel characteristics of diffractive optics	05
2	Design criteria of diffractive elements, Diffraction efficiency analysis of binary (Amplitude and Phase) and multi-level diffractive optics	06
3	Application of Diffractive Optics: Design exercises on applications of diffractive optics such as chromatic aberration corrections, null element in aspheric testing, and subwavelength gratings	06
4	Fabrication techniques for diffractive and micro optics ; Lithography, direct writing, replication and dynamic methods	06
5	Measurement and characterisation of diffractive and micro optics; profilometric, interferometric and slope measurement techniques	05
6	Polymer/plastic optics vs glass optics; optical properties of plastic optics, Manufacturing methods of plastic optics	06
7	Aspheric and freeform optics for imaging and non imaging applications, Fabrication and testing techniques of freeform optics	05
8	Application of Micro optics: Microoptical components/systems for beam shaping, MOEMS, and optical information technology	03
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12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. O'Shea, D C, Suleski, T J, Kathman, A D and Prather, D W ; Diffractive Optics :Design, Fabrication and Test, SPIE, 2008
2. Sinzinger, S and Jahns, J; Mirco Optics, Wiley, John & Sons Inc. 2003
3. Hentschel, R, Braunecker, B, Tiziani, H J ; Advanced Optics Using Aspherical Elements, SPIE 2008

4. Kress, B, Meyrueis, P; Digital Diffractive Optics: An Introduction to Planar Diffractive Optics and Related Technology , Wiley, John & Sons, 2001

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Department of Physics	
2.	Course Title (<i>< 45 characters</i>)	GREEN PHOTONICS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	PYL - 771	
6.	Status (<i>category for program</i>)	New Course, Open Elective for students of all Departments/Centres	

7.	Pre-requisites (<i>course no./title</i>)	EPL105,EPL336,	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	IDL737 (5%)	
8.2	Overlap with any UG/PG course of other Dept./Centre	PHL751(10%)	
8.3	Supercedes any existing course	No	

9.	Not allowed for (<i>indicate program names</i>)		
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course D. S. Mehta, P. Senthilkumaran, Prof. B. D. Gupta		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): Energy efficient, cost-effective, and environmental friendly (Clean) Photonics technology is important for our day to-day-life. Solid state lighting, Sunlight Harvesting, and Day Light Saving have all these advantages. Nonimaging optics is an ideal tool for designing optimized solar energy collectors and illumination optics for green lighting. The aim of the course is to develop understanding and experience about the Green photonics technologies their basic principles; solid state lighting and illumination engineering, materials, fabrication methods, lighting and illumination engineering of day light saving, solar concentrator, light guiding devices and diffuse lighting materials and devices.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Need for green photonics, Overview of solid-state lighting technologies and their advantages. Inorganic and Organic LEDs: Fundamentals, device physics, diode structures and operating principles. Materials for LEDs, OLEDs and		
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	PLEDs: phosphor materials and their characterisation. LEDs and OLED fabrication, encapsulation and packaging techniques. Electro-optical properties of LEDs and OLEDs; electric drive circuits, internal, external and power efficiency, spectral distribution, and encapsulants. Design and development of light out-coupling techniques. Photometry and colorimetry of LEDs and OLEDs. Free-form optics and design of LEDs and OLEDs based illumination systems: General lighting, traffic lights, automotive, street & flood lighting, and backlights for displays. Sunlight Harvesting Technologies, Non-imaging Solar Concentrators and illuminators: Parabolic and Fresnel lens, Diffractive, Microoptics and Free-form optics for lighting and illumination engineering of day light saving, light guiding devices and diffuse lighting materials and devices. Solar photovoltaics: Inorganic, Organic and Polymeric solar cells: Principles, Technology and Applications. Role of solar concentrators.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Review of present lighting technology: Tungsten-halogen, gas discharge, fluorescent and compact fluorescent lamps, their de-merits. Overview of solid-state lighting technologies and their advantages.	2
2	Solid State Lighting Technologies: Inorganic LEDs and Organic LEDs: Fundamentals, device physics, diode structures and operating principles, Materials for LEDs, OLEDs and PLEDs: inorganic, organic and polymeric light emitting materials. LED and OLED phosphor materials and their characterisation.	6
3	Electro-optical properties of LEDs and OLEDs; I-V characteristics, DC and AC electric drive circuits, carrier distribution, internal external and power efficiency, spectral distribution, light escape cone, and encapsulants.	4
4	Design and development of high performance single color, multicolor and white LEDs and OLEDs. Nanostructured high performance LEDs and OLEDs.	3
5	Light outcoupling techniques for LEDs and OLEDs. LED and OLED Luminaires, Microlenses, micro-prisms, free-form optical components, diffractive optical elements, micro- and nano-structured surfaces.	3
6	Design and development of LEDs and OLEDs based illumination systems: General illumination, traffic lights, automotive and street lighting, flood lighting, and backlights for large LCD displays.	2
7	Sunlight Harvesting: Non-imaging Solar Concentrators and illuminators: Parabolic and Fresnel lens, Diffractive, Microoptics and free-form optics for lighting and illumination engineering of day light saving.	4
8	Lighting and illumination engineering for day light saving technologies.	3
9	Optical Design and Systems for Solar Concentrators.	4
10	Optics of light guiding devices: light pipe, plastic optical fibers, and diffuse lighting materials and devices.	3
11	High Collection Nonimaging Optics for Sunlight Harvesting	4
12	Solar photovoltaics: Inorganic, Organic and Polymeric solar cells: Principles, Technology and Applications. Role of solar concentrators.	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

- i. Schubert, E. Fred, Light-emitting diodes. Cambridge Univ. Press, 2003.
- ii. Nalwa Hari Singh, Handbook of luminescence, display materials, and devices, American Scientific Publishers, Vol I, II and III 2003.
- iii. Zakauskas, A., Shur, M., Gaska, R., Introduction to Solid State Lighting.
- iv. W.T. Welford and R. Winston, "High Collection Nonimaging Optics", Academic Press Inc., pp. 53-273 (1989).
- v. R. Winston, J.C. Minano and P. Benitez, "Nonimaging Optics", Elsevier Academic Press, pp. 1-217, (2005).
- vi. J.C. Chaves, "Introduction to Nonimaging Optics", Taylor and Francis Group LLC., pp.12-324 (2008).
- vii. Nonimaging Fresnel Lenses: Design and Performance of Solar Concentrators (Springer Series in Optical Sciences) by Ralf Leutz and Akio Suzuki (Dec 7, 2010).
- viii. The Physics of Solar Cells (Properties of Semiconductor Materials) by Jenny Nelson (Sep 5, 2003).
- ix. High collection nonimaging optics, W. T. Welford, Roland Winston.
- X. Illumination Engineering: Design with Nonimaging Optics, R. John Koschel

19. Resources required for the course (itemized & student access requirements, if any)

19.1	Software	MATLAB
19.2	Hardware	PC
19.3	Teaching aides (videos, etc.)	OHP, LCD Projectors
19.4	Laboratory	NIL
19.5	Equipment	NIL
19.6	Classroom infrastructure	OHP, LCD Projector
19.7	Site visits	Lighting industry, and National Labs.

20. Design content of the course (Percent of student time with examples, if possible)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	PLASMONIC SENSORS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL772
6.	Status (<i>category for program</i>)	Programme Elective

7.	Pre-requisites (course no./title)	None
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	PYL791(5%)
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Professor B.D. Gupta, Prof.Anurag Sharma, Prof.Joby Joseph	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): The field of photonic sensing has shown extraordinary capabilities of highly sensitive and accurate sensors. The collaboration of spectroscopic techniques such as plasmonics with optical fiber technology leads to miniaturized, low cost sensing probes. These sensors provide high sensitivity and detection accuracy along with the additional benefits of remote sensing, miniaturization, low cost and online monitoring. The objective of this course is to introduce the students the field of photonic sensors and its application in sensing of various physical, chemical and biological parameters. The emphasis will be mainly on plasmonic based sensors.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Optical fiber, optical fiber sensors, characteristics and components of optical fiber sensors, Spectroscopic techniques, Modulation schemes; Physics of plasmons, surface plasmons at semi-infinite metal-dielectric interface, excitation of surface plasmons, surface plasmon resonance (SPR) condition,	
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	interrogation techniques; Theory of SPR based optical fiber sensors, N-layer model, excitation by meridional rays: on axis excitation, performance parameters: sensitivity, detection accuracy and figure of merit; SPR based sensing applications, refractive index and other analytes sensing, multichannel sensing, multianalyte sensing; Factors affecting performance of the sensor: fiber parameters, change of metal, high index dielectric material, probe design, temperature and ionic fluid.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Optical fiber, optical fiber sensors, characteristics and components of optical fiber sensors, Spectroscopic techniques, Modulation schemes with examples of sensors	10
2	Surface plasmons: an introduction, physics of plasmons, surface plasmons at semi-infinite metal-dielectric interface, excitation of surface plasmons, prism, grating and waveguide, surface plasmon resonance (SPR) condition, interrogation techniques	8
3	Theory of SPR based optical fiber sensor, N-layer model, excitation by meridional rays: on axis excitation, performance parameters: sensitivity, detection accuracy and figure of merit	8
4	SPR based sensing applications, refractive index and other analytes sensing, multichannel sensing, multianalyte sensing	8
5	Factors affecting performance of the sensor: fiber parameters, change of metal, high index dielectric material, probe design, temperature and ionic fluid.	8
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COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Nil	
2		
3		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. B.D. Gupta, S.K. Srivastava and R.Verma, Fiber optic sensors based on plasmonics, World Scientific, 2015.
2. J. Jomola (Ed.), Surface plasmon resonance based sensors, Springer, 2006.
3. S.A. Maier, Plasmonics: Fundamentals and applications, Springer, 2007.

4. B.D. Gupta, Fiber optic sensors: Principles and applications, NIPA, 2006.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	STATISTICAL AND QUANTUM OPTICS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL757
6.	Status (<i>category for program</i>)	Programme Elective

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supercedes any existing course	

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course Kedar Khare, D. S. Mehta, Joyee Ghosh	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): This course first provides treatment of optical phenomena by going beyond Maxwell equations to explicitly treat generation/propagation/detection of light as statistical random processes. Classical and quantum treatment of coherence properties of optical fields and their applications are discussed.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Probability theory, generating function, characteristic function; Analytic signal representation, correlation and spectral properties, Temporal, spatial and partial coherence, law of interference, spectral interference, Coherent mode representation, Propagation of coherence; Higher order correlations; photodetection probability, Mandel's photon counting formula; Intensity interferometry, speckle statistics and applications, Field quantization, number states, coherent states, Glauber-Sudarshan representation, tests for non-classicality, quantum correlations, two photon coherence function and coincidence count rate, quantum treatment of beamsplitter and simple	
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	interferometers
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Probability distributions, moment generating function and characteristic function, Gaussian distribution, central limit theorem, analytic signal representation	4
2	Random processes, correlations, stationarity, Wiener-Khintchine theorem	4
3	Temporal and spatial coherence, coherence function, Law of interference (2 slit experiment), spectral interference law, degree of polarization, Coherent mode representation in space-frequency domain	5
4	Propagation of coherence function, van Cittert Zernike theorem, Michelson stellar interferometer	4
5	Mandel's photon counting formula, Intensity correlations, Hanbury Brown Twiss effect, intensity interferometry	4
6	Speckle statistics and applications	4
7	Quantization of EM fields, number states, vacuum fluctuations	4
8	Coherent states, Glauber-Sudarshan representation, test for non-classicality, bunching and anti-bunching	5
9	Quantum correlation functions, normal and time ordering, two photon coherence function and coincidence rate	4
10	Quantum treatment of beamsplitter and interferometers	4
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12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
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7		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

L. Mandel and E. Wolf, Coherence and Quantum Optics, Cambridge Univ. Press 1995
 J. W. Goodman, Statistical Optics, Wiley 2000
 D. F. Walls and G. J. Milburn, Quantum Optics, Springer, 2nd ed 2008
 S. Chopra, Statistical and Quantum Optics, Narosa Publishing 2013

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	ULTRAFAST OPTICS & APPLICATIONS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	PYL 770	
6.	Status (<i>category for program</i>)	Programme Elective	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	Yes, PYL 412	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Dr MR Shenoy, Dr RK Soni, Dr GV Prakash, Dr Ajit Kumar, Dr Anurag Sharma, Dr Joyee Ghosh, Dr Amartya Sengupta		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): This course will address issues regarding ultrafast laser pulses and their applications. Topics to be covered include: Generation, propagation and applications of ultrashort pulses; Linear and nonlinear pulse shaping processes; Noise in mode-locked lasers and its limitations in measurements; Applications in research and industry		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Generating and measuring Ultrashort Optical Pulses.- Ultra-Broadband Optical Parametric Amplifiers.- Advances in Solid-State Ultrafast Laser Oscillators.- Ultrafast Quantum Control in Atoms and Molecules.- Femtosecond Optical Frequency Combs.- Ultrafast Material Science Probed using Coherent X-Ray Pulses from High-Harmonic Generation.- Ultrafast Nonlinear Fibre Optics and Supercontinuum Generation.- Nonlinear Wavelength Conversion and Pulse Propagation in Optical Fibres.- Applications of Ultra-Intense, Short Laser		
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	Pulses.- Utilising Ultrafast Lasers for Multiphoton Biomedical Imaging.- Femtosecond Laser Micromachining.- Technology and Applications of THz waves, Ultrafast Nonlinear Microscopy,- Attosecond Generation.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Ultrafast Optics	2
2	Maxwell-Bloch Equation, Two-Level Atoms and Rabi Flopping Dispersion, Absorption, Gain	5
3	Rate Equations and Relaxation Oscillation, Q-Switching	3
4	Generating ultrafast pulses, Active Mode-Locking, Semiconductor Saturable Absorber Mode-Locking	4
5	Nonlinear Propagation of ultrafast pulses, dispersion compensation, Four-wave mixing and continuum generation in optical fibers	6
6	Pulse Characterization I - Autocorrelation Pulse Characterization II - FROG and SPIDER	4
7	Noise in Modelocked lasers, Optical Frequency Combs, Frequency metrology, Ultrafast interferometry	5
8	Ultrafast Quantum Control, Pulse shaping, coherent control of chemical reactions, Material studies using ultrafast spectroscopy	3
9	Industrial & Medical Applications of ultrafast pulses, Ultrafast micro-machining, OCT and Medical Imaging	4
10	THz waves, Ultrafast Nonlinear Microscopy, Higher harmonics, Ultrafast X-ray Pulses, Attosecond Pulse Generation	6
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Weiner, Andrew. Ultrafast Optics. New York, NY: John Wiley and Sons, 2009. ISBN: 9780471415398.

Diels, Jean-Claude, Wolfgang Rudolph, Paul Liao, and Paul Kelley. Ultrashort Laser Pulse Phenomena: Fundamentals, Techniques, and Applications on a Femtosecond Time Scale. Burlington, MA: Academic Press, 1996. ISBN: 0122154924.

Kärtner, F. X., ed. Topics in Applied Physics: Few-Cycle Laser Pulse Generation and Its

Applications. Vol. 95. New York, NY: Springer-Verlag, 2004. ISBN: 3540201157.
 Rulliere, Claude. Femtosecond Laser Pulses and Experiments. New York, NY: Springer, 2005. ISBN 978-0-387-26674-9
 Haus, Herman. Waves and Fields in Optoelectronics. Upper Saddle River, NJ: Prentice Hall, 1984. ISBN: 0139460535.
 Allen, L., and J. H. Eberly. Optical Resonance and Two Level Atoms. New York, NY: John Wiley and Sons, 1987. ISBN: 0486655334.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
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20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)