

Revised M. Tech. Curriculum
on
JOP Program
Opto-Electronics and Optical Communication



Submitted by

R. K. Varshney

Program Coordinator

Opto-Electronics and Optical Communication

Physics Department, IIT Delhi

Revised M. Tech. Curriculum for JOP Program Opto-electronics and Optical Communication

Overall credit structure: Total Credits = 51

Overall Core/ Elective Credits

Program Core (PC) Credits	Program Elective (PE) Credits (including Open Category(OC))	Total Credits
24 [12 (Th) + 6 (Lab) + 6 (Proj Part-I)]	27 [24* PE +3 PE/ OC]	51
PH (Theory): 6 Cr	*Minimum 6 credits of PYL courses and 6 credits of ELL courses	
EE (Theory): 6 Cr		

Semester wise course scheduling in the new scheme:

Semester-I

S.No.	Course Title	Course No	Type	L-T-P	Credits
1	Fiber Optics	PYL791	PC	3-0-0	3
2	Digital Comm. & Inform. System	ELL727	PC	3-0-0	3
3	Laboratory-I (Fiber Optics Lab/ Opt. Comm. Lab)	JOP791	PC	0-0-6	3
4	Programme Elective-I	PYL/ELL	PE	3-0-0	3
5	Programme Elective-II	PYL/ELL	PE	3-0-0	3
Semester total				12-0-6	15

Semester II

S.No.	Course Title	Course No	Type	L-T-P	Credits
1	Optical Electronics	PYL792	PC	3-0-0	3
2	Optical Communication System	ELL717	PC	3-0-0	3
3	Laboratory-II (Fiber Optics Lab/ Opt. Comm. Lab)	JOP792	PC	0-0-6	3
4	Programme Elective-III	PYL/ELL	PE	3-0-0	3
5	Programme Elective-IV	PYL/ELL	PE	3-0-0	3
Semester total				12-0-6	15

Semester III

S.No.	Course Title	Course No	Type	L-T-P	Credits
1	Programme Elective-V		PE/OC	3-0-0	3
2	Major Project Part-I	JOD801	PC	0-0-12	6
Semester total (max)				3-0-12	9

Semester IV

S.No.	Course Title	Course No	Type	L-T-P	Credits
1	Major Project Part-II or 12 Credits PE Courses in lieu of Major Project Part-II)	JOD802	PE PE	0-0-24	12
Total Credits				0-0-24	12

Core Courses (24 Credits)

Course No.	Course Title	L-T-P	Credits
PYL791	Fiber Optics	3-0-0	3
PYL792	Optical Electronics	3-0-0	3
ELL727	Digital Comm. & Inform. System	3-0-0	3
ELL717	Optical Communication System	3-0-0	3
JOP791	Laboratory-I (Fiber Optics Lab/ Opt. Comm. Lab)	0-0-6	3
JOP792	Laboratory-II (Fiber Optics Lab/ Opt. Comm. Lab)	0-0-6	3
JOD801	Major Project Part-I	0-0-12	6

Tentative Program Elective Courses

Course No.	Course Title	L-T-P	Credits
Physics Courses			
PYL795	Optics and Lasers	3-0-0	3
PYL793	Photonic Devices	3-0-0	3
PYL891	Fiber Optic Components and Devices	3-0-0	3
PYL790	Integrated Optics	3-0-0	3
PYL892	Guided Wave Photonic Sensors	3-0-0	3
PYL755	Statistical and Quantum Optics	3-0-0	3
PYL758	Biomedical Optical Imaging and Bio-photonics	3-0-0	3
PYL771	Green Photonics	3-0-0	3
PYL770	Ultra-fast optics and applications	3-0-0	3
PYL756	Fourier optics and holography	3-0-0	3
EE Courses			
ELL728	Optoelectronic Instrumentation	3-0-0	3
ELL820	Photonics Switching & Networking	3-0-0	3
ELL814	Wireless Optical Communications	3-0-0	3
ELL723	Broadband Comm. Systems	3-0-0	3
ELL819	Introduction to Plasmonics	3-0-0	3
ELL726	Nano-Photonic and Plasmonics	3-0-0	3
ELL724	Computational Electromagnetics	3-0-0	3
ELL720	Digital Signal Processing-I	3-0-0	3
ELL721	Computer Communication Network	3-0-0	3
ELL716	Telecommunication Switching and Transmission	3-0-0	3
JOP Courses			
JOD802	Major Project Part-II	0-0-24	12
JOL793	Selected Topics-I	3-0-0	3
JOL794	Selected Topics-II	3-0-0	3
JOS795	Independent Study	0-3-0	3
JOV796	Selected Topics in Photonics	1-0-0	1

Please note the following points:

1. Templates of PYL755, PYL758, PYL771, PYL770 & PYL756 courses are included in the list of M. Tech. Applied Optics program.
2. Templates of ELL720, ELL721 & ELL716 courses are included in the list of M. Tech. Communication Engineering (EEE) program.

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Optical Communication Systems
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL717
6.	Status (<i>category for program</i>)	Program Core for JOP

7.	Pre-requisites (<i>course no./title</i>)	EEL769- Digital Communication and Information System
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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	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supersedes any existing course	None

9.	Not allowed for (<i>indicate program names</i>)	NIL
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course: Prof. V K Jain, Prof. Subrat Kar, Prof. D. Chadha
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives (<i>about 50 words</i>): To equip students with understanding of Optical fiber communication systems, their analysis and design. Issues in advanced DWDM system, Impairments in optical system, etc.
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14.	Course contents (about 100 words) (Include laboratory/design activities): The fiber channel with its linear and nonlinear characteristics, LED and Laser diode transmitter design, PIN and APD receiver design, Modulation schemes, Source and line coding in optical systems. Optical Link design with dispersion and power budgeting. Design of digital and analog communication systems. Optical amplifiers, WDM system design. Hybrid fiber co-axial/microwave links
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1.	Introduction to Optical Communication System	
	1.1. Optical Transmitters: LED/Laser transmitter design	4
	1.2 Fiber Channel with its linear and non-linear characteristics	3
	1.3 Optical Receivers: Various receiver configurations, sensitivity & SNR, BER calculations	5
2.	Optical Coherent transmission Systems	5
3.	Modulation and line coding schemes	3
4.	Optical fiber link budgeting	3
5.	Analog optical systems	4
6.	Optical amplifiers	5
7.	WDM systems	6
8.	Radio over fiber systems	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

18. Suggested texts and reference materials

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

1. Keiser, G., Optical Fiber Communications, 5th Ed., McGraw-Hill, 2013
2. Agarwal, G. P. , Fiber-Optical Communication Systems, 3rd Ed., John Wiley , 2012
3. Senior, J. M., Optical Fiber Communications-Principles and Practice, 3rd Ed., Pearson Education, 2009
4. Selvarajan A, Kar S., Srinivas T, Optical Fiber Communication, Principles and System, Tata McGraw-Hill Publishing Company, 2006.

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

19.1	Software	Optical system design software, e.g. RSoft- OptiSim
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	
19.8	Others (please specify)	

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

20.1	Design-type problems	25%
20.2	Open-ended problems	10% , Using simulation tools to design optical communication system
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	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Broadband Communication Systems
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL723
6.	Status (<i>category for program</i>)	Program Elective for JOP, EEE, JTM

7.	Pre-requisites (<i>course no./title</i>)	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	Supersedes any existing course	EEL 895

9.	Not allowed for (<i>indicate program names</i>)	Nil
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ X 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Prof Subrat Kar, Prof V.K. Jain, Prof Vinod Chandra
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives (<i>about 50 words</i>): To understand the protocols, switches and techniques like spread spectrum and OFDM, which have been used in broadband communication systems.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Multiple Access Techniques – CSMA, Spread Spectrum (SS), Direct Spread SS, Frequency Hopping SS and CDMA, Timing Synchronization, Delay Lock Loop, ISDN Physical Layer, ISDN Data Link Layer, Signaling System Number 7, Broadband ISDN Protocols, ATM Switch and Protocols, CLOS Network Switch, OFDM Concept, OFDMA System, Multi-Carrier CDMA, WiMAX
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Multiple Access Techniques – CSMA, Spread Spectrum (SS)	4
2	Direct Spread SS, Frequency Hopping SS and CDMA	5
3	Timing Synchronization, Delay Lock Loop	3
4	ISDN Physical Layer, ISDN Data Link Layer	4
5	Signaling System Number 7	4
6	Broadband ISDN Protocols	3
7	ATM Switch and Protocols	4
8	CLOS Network Switch	3
9	OFDM Concept , OFDMA System	5
10	Multi-Carrier CDMA	3
11	WiMAX	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	Nil	Nil

17. Brief description of laboratory activities : NIL

18. Suggested texts and reference materials

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

1. Stallings W., ISDN and Broadband ISDN with Frame Relay and ATM, 4th Edition, Pearson Education, 2000
2. Chao H.J., Lam C.H. and Oki E., Broadband Packet Switching Technologies – A Practical Guide to ATM Switches and IP Routers, 1st Edition, Wiley, 2001
3. Jha U.S. and Prasad R., OFDM Towards Fixed and Mobile Wireless Access, 1st Edition, Artech House, 2007
4. Fazel K. and Kaiser S., Multi-Carrier and Spread Spectrum Systems – From OFDM and MC-CDMA to LTE and WiMAX, 2nd Edition, Wiley, 2008
5. Lee T. and Liew S.C., Principles of Broadband Switching and Networking, 1st Edition, Wiley, 2010

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

19.1	Software	Matlab
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	Projection Facilities
19.7	Site visits	Nil
19.8	Others (please specify)	Nil

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

20.1	Design-type problems	25% of the time will be allocated to solving design problems
20.2	Open-ended problems	Nil
20.3	Project-type activity	Nil
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Nanophotonics and Plasmonics
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL726
6.	Status (<i>category for program</i>)	PG Course, Open to UG students (Program elective for JOP students)

7.	Pre-requisites (course no./title)	PHL100, EEL207 (or any equivalent course on engineering electromagnetics)
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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. Anuj Dhawan, Dr. Kushal K. Shah	
12.	Will the course require any visiting faculty?	No

13.	Course objective <i>(about 50 words)</i> : The motivation for the course is to make the students understand the fundamentals and physics of plasmonics and nano-photonics, as well as plasmonic and nano-photonic devices.
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14.	Course contents <i>(about 100 words) (Include laboratory/design activities)</i> : EM Waves, Maxwell's Equations, Boundary Conditions, Drude, Debye, Lorentz-Drude Dispersion Relation Models, Introduction to Surface Plasmons, Surface Plasmon Excitation Mechanisms, Plasmonic Nanogratings, Localized Surface Plasmon based Devices, Optical and Plasmonic Interconnects, Sensors based on Surface Plasmons, SERS based sensing, Photonic Crystals, Optical Metamaterials, Fabrication of Nanomaterials and Plasmonic Devices
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1.	EM Waves, Maxwell's Equations, Boundary Conditions	1
2.	Drude, Debye, Lorentz-Drude Dispersion Relation Models	2
3.	Introduction to Surface Plasmons	2
4.	Surface Plasmon Excitation Mechanisms	2
5.	Plasmonic Nanogratings	4
6.	Localized Surface Plasmon based Devices	4
7.	Optical and Plasmonic Interconnects	6
8.	Sensors based on Surface Plasmons	3
9.	SERS based sensing	4
10.	Photonic Crystals	4
11.	Optical Metamaterials	4.5
12.	Fabrication of Nanomaterials and Plasmonic Devices	4.5
12		
COURSE TOTAL <i>(14 times 'L')</i>		42

16. Brief description of tutorial activities - None**17. Brief description of laboratory activities** - None

Suggested texts and reference materials

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

S. Maier, Plasmonics - Fundamentals and Applications, First Edition, Springer, 2007
L. Novotny and B. Hecht, Principles of Nano-optics, Second Edition, Cambridge University Press, 2012

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

19.1	Software	NIL
19.2	Hardware	NIL
19.3	Teaching aides (videos, etc.)	NIL
19.4	Laboratory	NA
19.5	Equipment	NIL
19.6	Classroom infrastructure	A big classroom with a projector and large black board.
19.7	Site visits	NA

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

20.1	Design-type problems	
20.2	Open-ended problems	10%
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	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Digital Communication and Information Systems
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL727
6.	Status (<i>category for program</i>)	Core for JOP

7.	Pre-requisites (<i>course no./title</i>)	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	Supersedes any existing course	Nil

9.	Not allowed for (<i>indicate program names</i>)	EEE, CRF, JTM
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10.	Frequency of offering	☐ Every sem ☐ X 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Prof V.K. Jain, Prof Vinod Chandra, Prof. Devi Chadha, Dr. Kushal Shah
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives (<i>about 50 words</i>): To enable the students to get understanding of digital modulation schemes and their performance in noise. Introduction to information theory concepts and coding schemes for error correction.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Review of Fourier Transforms, Sampling Theorem, Quantization, Pulse Code Modulation, Digital Modulation Schemes – BPSK, QPSK, BFSK, QASK, MPSK, Random Processes, Probability density function, Gaussian density function, Frequency domain representation of noise, Spectral components of noise, Noise bandwidth, Properties of noise, Noise Performance Analysis of digital modulation schemes. Information Theory, Concept of information, Coding to increase average information per bit, Shannon's theorem, Capacity of Gaussian Channel, Bandwidth-S/N tradeoff. Discrete memory-less channel capacity. Error correcting codes, Block codes, Cyclic redundancy check, Coding gain, Bit error rate calculations.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Review of Fourier Transforms, Sampling Theorem	3
2	Quantization, Pulse Code Modulation	3
3	Digital Modulation Schemes – BPSK, QPSK, BFSK, QASK, MPSK,	6
4	Random Processes, Probability density function, Gaussian density function	3
5	Frequency domain representation of noise, Spectral components of noise	3
6	Noise bandwidth, Properties of noise	3
7	Performance Analysis of digital modulation schemes	6
8	Information Theory, Concept of information, Source Coding	3
9	Shannon's theorem, Capacity of Gaussian Channel	2
10	Bandwidth-S/N tradeoff. Discrete memory-less channel capacity.	4
11	Error correcting codes, Block codes, Cyclic redundancy check, Coding gain, Bit error rate calculations	6
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	Nil	Nil

17. Brief description of laboratory activities : NIL

18. Suggested texts and reference materials

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

1. Taub H., Schilling D.L. and Saha G., Principles of Communication Systems, 4th Edition, Tata McGraw Hill, 2013
2. Lathi B.P. and Ding Z., Modern Digital and Analog Communication Systems, 4th Edition, Oxford University Press, 2011
3. Haykin S., Communication Systems, 4th Edition, Wiley, 2001

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

19.1	Software	Matlab
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	Projection Facilities
19.7	Site visits	Nil
19.8	Others (please specify)	Nil

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

20.1	Design-type problems	25% of the time will be allocated to solving design problems
20.2	Open-ended problems	Nil
20.3	Project-type activity	Nil
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Optoelectronic Instrumentation
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL728
6.	Status (<i>category for program</i>)	Program Elective for JOP

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	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	Nil
8.3	Supersedes any existing course	Nil

9.	Not allowed for (indicate program names)	NIL
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10.	Frequency of offering	☐ Every sem x ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Prof. V.K.Jain, Prof. V.Chandra
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives (<i>about 50 words</i>): The objective of this course is to expose the students to electronics circuit design and instrumentation. Topics like analog and digital signal processing, spectrum analyzer, electronic pre-amplifiers design, optical amplifiers, interface, display devices, etc. will be discussed.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Introduction to test and measuring instruments, instrumentation amplifier, chopper stabilized amplifier, analog signal processing: active filter, A/D, D/A converters, integrated, transimpedance and low impedance pre-amplifiers design, sample & hold circuits, multiplexer, peak detector, zero crossing detector etc., digital design: PALs, FPGA, signal analyzer: superheterodyne spectrum analyzer, DFT and FFT analyzer, digital filters and computer interface, microcontrollers: introduction to microcontroller and applications such as 8031, optical post, in-line and pre-amplifiers, noise figure, optoelectronic circuits: transmitter and receiver design, OTDR, optical spectrum analyzer, sensors: fiber optic and radiation types, distributed sensors, fiber optic smart structure, display devices.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1.	Introduction to test and measuring instruments, instrumentation amplifier, chopper stabilized amplifier	7
2.	Analog signal processing: active filter, A/D, D/A converters, integrated, transimpedance and low impedance pre-amplifiers design	8
3.	Sample & hold circuits, multiplexer, peak detector, zero-crossing detector, digital design: PALS, FPGA	6
4.	Signal analyzer: superheterodyne spectrum analyzer, DFT and FFT analyzer, digital filters and computer interface, microcontrollers: introduction to microcontroller and applications such as 8031	7
5.	Optical post, in-line and pre-amplifiers, noise figure, optoelectronic circuits: transmitter and receiver design, OTDR, optical spectrum analyzer	9
6.	Sensors: fiber optic and radiation sensors, distributed sensors, fiber-optic smart structure, display devices	5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities: Nil

Module no.	Description	No. of hours

17. Brief description of laboratory activities: Nil

18. Suggested texts and reference materials

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

References:

1. Robert A. Witte, Electronic Test Instrumentation: Analog and Digital Measurement, Pearson Education, 2004.
2. Giorgio Rizzoni, Principles and Applications of Electrical Engineering, Tata McGraw-Hill, Fourth Edition, 2003.
3. Jeff Hecht, Understanding Fiber Optics, SAMS Publishing, 1997.
4. J.H.Franz, V.K.Jain, Optical Communications: Components and Systems, Narosa Publishing House, 2000.
5. Le Nguyen Binh, Digital Processing: Optical Transmission and Coherent Receiving Techniques, CRC Press, 2014.
6. Amar K.Ganguly, Optical and Optoelectronic Instrumentation, Narosa, 2010.

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

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD with power point presentation facility
19.7	Site visits	Nil
19.8	Others (please specify)	Nil

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

20.1	Design-type problems	25% for design problem solving
20.2	Open-ended problems	Nil
20.3	Project-type activity	Nil
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Wireless Optical Communications
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL814
6.	Status (<i>category for program</i>)	Program Elective for JOP

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	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	Nil
8.3	Supersedes any existing course	Nil

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1stsem x ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Prof. V.K.Jain, EED Prof. D. Chadha, EED	
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives (about 50 words): When light is transmitted through optical fiber, transmission integrity is quite predictable. Unfortunately when the light transmission is through the air, it must contend with a complex and not always predictable channel - <i>the atmosphere</i> . The fundamental limitation of wireless optical communication (WOC) systems arises from the environment through which light signal propagates. The modulation and demodulation techniques used in WOC systems are quite different from those used in optical fiber systems. In this course, the students would be exposed to atmospheric/free-space channel characterization, transmitter and receiver design and link feasibility.
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14.	Course contents (about 100 words) (Include laboratory/design activities): General introduction, optical channel modeling, background noise calculations, Modulation techniques: <i>M</i> -PPM, OOK, <i>m</i> $\times$ <i>n</i> PAPM, subcarrier modulation, DPPM, DHPIM, DAPPM, psd and bandwidth requirement evaluation, Detection techniques - Photon counter, PMT, coherent techniques, bit error rate evaluation in presence of atmospheric turbulence, concept of adaptive threshold, effect of turbulence and weather conditions viz., drizzle, haze fog on error performance and channel capacity, link availability.
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	General introduction, optical channel - Beam divergence, atmospheric losses, weather condition influence, atmospheric turbulence effects viz., scintillation, beam wander, beam spreading, etc.	7
2	Channel modeling - Linear time invariant model, channel transfer function, optical transfer function, models of turbulence induced fading viz., lognormal, exponential, K distribution, I-K distribution, gamma-gamma distribution, Optical wave models - Plane, spherical and Gaussian, range equation, transmitting and receiving antenna gains	9
3	Background noise source, detector FOV, diffraction limited FOV, spatial modes, background noise power calculation	5
4	Modulation techniques - power efficiency, BW efficiency, bit versus symbol error rates, error rate evaluation for isochronous modulation schemes viz., <i>M</i> -PPM, OOK, <i>m</i> $\times$ <i>n</i> PAPM schemes, subcarrier modulation, anisochronous modulation schemes - DPPM, DHPIM, DAPPM, psd and bandwidth requirement	10
5	Detection techniques - Photon counter, PIN/APD, PMT, coherent techniques viz., homodyne and heterodyne, bit error rate evaluation in presence of atmospheric turbulence, concept of adaptive threshold	5
6	Effect of turbulence and weather conditions viz., drizzle, haze fog on error performance and channel capacity, link availability	6
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities: Nil

17. Brief description of laboratory activities: Nil

18. Suggested texts and reference materials

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

References:

1. Z.Ghassemlooy, W.Popoola, S.Rajbhandari, Optical Wireless Communications, CRC Press, 2013.
2. L.C.Andrews, R.L.Phillips, Laser Beam Propagation through Random Media, SPIE Press, USA, 2005.
3. J.H.Franz, V.K.Jain, Optical Communications: Components and Systems, Narosa Publishing House, 2000.
4. D.Chadha, Terrestrial Wireless Optical Communication, Tata McGraw-Hill, 2012.

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

19.1	Software	Nil
19.2	Hardware	Nil
19.3	Teaching aides (videos, etc.)	Nil
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD with power point presentation facility
19.7	Site visits	Nil
19.8	Others (please specify)	Nil

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

20.1	Design-type problems	25% for design problem solving
20.2	Open-ended problems	Nil
20.3	Project-type activity	Nil
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Photonic Switching & Networking
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL820
6.	Status (<i>category for program</i>)	Program Elective for JOP

7.	Pre-requisites (<i>course no./title</i>)	Optical Communication Systems (EEL712)
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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	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supersedes any existing course	None

9.	Not allowed for (<i>indicate program names</i>)	Nil
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Prof. Subrat Kar, Prof. D. Chadha
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives (<i>about 50 words</i>): To equip students with understanding of Optical Switching and Networking systems. To study the enabling devices used in the networks and the different types of optical networks. Study the algorithms used for routing and access of networks. Management and control issues in optical networks.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Study of different types of networks, the enabling technologies and devices. Broadcast and Select network. Single and Multi-hop networks with example of Access networks, PONS etc., Wavelength Routing network, virtual topology, Metro and Wide area networks. Wavelength Routing and Assignment, Traffic Grooming and Protection, Network Control and Management, Optical packet and burst switching, Network Simulation Tools and Design guidelines.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1.	Telecom network architecture, Advantages of optical network, Optical network evolution, WDM optical networks, Different types of WDM networks, broadcast and select optical WDM network, wavelength routed optical WDM network, Challenges of optical WDM network.	2
2	Optical network enabling technologies and devices: Optical transmitters, tunable and fixed laser, Optical receivers, tunable and fixed optical filters, optical amplifiers; EDFA, Raman amplifier, SOA, MUX-DEMUX, OADM, OXC, large optical switching fabric architectures, wavelength convertors.	7
3.	Broadcast and Select Networks: single and multi-hop networks, Media –access control protocol, LAMBDANET, STARNET, Rainbow, Shufflenet, De Bruijn Graph, Hypercube.	6
4.	Introduction to access network, Gig Ethernet, Radio over Fiber network, different optical access networks; EPON and WDM EPON; WRPON, Access algorithms, STARGATE.	6
5.	Introduction to metro network, traffic grooming overview, static and dynamic traffic grooming. Traffic grooming in SONET ring and WDM ring, ATM, IP, SONET/SDH layers, RINGOSTAR	5
6.	Introduction to Wavelength Routing Network, Problem formulation, routing sub-problem: routing algorithms, wavelength assignment sub-problem, algorithms, Virtual topology design, ILP formulation.	6
7.	Optical packet switching, header and packet format, contention resolution in OPS networks, OPS node architecture, optical burst switching, signaling and routing protocols for OBS networks, contention resolution in OPS networks, implementation and application. MEMs based switching, switching with SOAs, lamda switches.	6
8.	Control and Management functions in optical networks, configuration management, performance management, Fault management	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

17. Brief description of laboratory activities

18. Suggested texts and reference materials

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

1. Biswanath Mukherjee, Optical WDM Networks, Springer, 2006
2. R.Ramaswami, K.Sivarajan, G. Sasaki, Optical Networks- A Practical Perspective, 3rd Ed., Elsevier Publication, 2009.
3. Thomas E. Stern, Georgios Ellinas, Krishna Bala, Multiwavelength Optical Networks: Architectures, Design, and Control, 2nd Ed., Cambridge University Press, 2009
4. Mayer & Martin, Optical Switching Networks, Cambridge University Press, 2008.
5. Siva Ram Murthy, Mohan Gurusamy, WDM Optical Networks: concepts, Design, and Algorithms, Prentice–Hall, 2002

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

19.1	Software	Optical network simulation software, i.e, RSoft Artifex, Matlab SimEvent
19.2	Hardware	NIL
19.3	Teaching aides (videos, etc.)	NIL
19.4	Laboratory	NIL
19.5	Equipment	NIL
19.6	Classroom infrastructure	Basic infrastructure
19.7	Site visits	NIL
19.8	Others (please specify)	NIL

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

20.1	Design-type problems	25%
20.2	Open-ended problems	10%
20.3	Project-type activity	NIL
20.4	Open-ended laboratory work	NIL
20.5	Others (please specify)	NIL

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	PHOTONIC DEVICES
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	PYL 793
6.	Status (<i>category for program</i>)	Programme Elective for JOP

7.	Pre-requisites (course no./title)	PYL201 or PHL554
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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 312
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. M R Shenoy, Prof. R K Soni, Dr G V Prakash, Dr Amartya Sengupta	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): To provide a detailed exposure to the physics, principle of operation, design, and characteristics of widely used semiconductor optoelectronic devices for applications in Optoelectronics, Optical Communication and Optical Signal Processing. Specific emphasis will be on semiconductor optical amplifiers, sources, detectors, and modulators, which also lead to the realization of Photonic Integrated Circuits.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Review of Semiconductor Physics for Photonics: The Density of States $\rho(k)$ and $\rho(E)$; Density of States in a Quantum Well Structure; Carrier Concentration & Fermi Level; Quasi Fermi Levels. Semiconductor Optoelectronic Materials; Heterostructures, Strained-Layers, Bandgap Engineering; p-n junctions; Schottky Junctions & Ohmic Contact. Interaction of Photons with Electrons and Holes in a Semiconductor; Rates of Emission and Absorption; Amplification by Stimulated Emission; The	
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	Semiconductor Optical Amplifier. Quantum Confined Stark Effect and Franz-Keldysh Effect. Electro-absorption Modulator: Principle of Operation and Device Configuration. Light Emitting Diode: Device Structure and Output Characteristics, Modulation Bandwidth, Materials for LED, and Applications. White light LEDs. Laser Diodes: Device Structure and Output Characteristics, Single Frequency Lasers; DFB, DBR Lasers, VCSEL, Quantum Well and Quantum Cascade Laser, Micro-cavity lasers. Modulation of Laser Diodes, Practical Laser Diodes & Handling. Photodetectors: General Characteristics of Photodetectors, Impulse Response, Photoconductors, PIN, APD, Array Detectors, CCD, Solar Cell. Photonic Integrated Circuits.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Review of Semiconductor Physics for Photonics: The Band Structure; The Density of States $\rho(k)$ and $\rho(E)$; Density of States in a Quantum Well Structure; Carrier Concentration & Fermi Level; Quasi Fermi Levels. Semiconductor Optoelectronic Materials; Heterostructures, Strained-Layers, Bandgap Engineering; Heterostructure p-n junctions; Schottky Junctions & Ohmic Contact.	6
2	Interaction of Photons with Electrons and Holes in a Semiconductor; Optical Joint Density of States, Probabilities of Emission and Absorption; Rates of Emission and Absorption; Absorption Spectrum of Semiconductors. Amplification by Stimulated Emission; The Semiconductor Optical Amplifier.	8
3	Absorption Spectrum of Quantum Well Structures; Quantum Confined Stark Effect and Franz-Keldysh Effect. Electro-absorption Modulator: Principle of Operation and Device Configuration.	4
4	Injection Electroluminescence. Light Emitting Diode: Device Structure and Output Characteristics, Modulation Bandwidth, Materials for LED, and Applications. White light LEDs.	4
5	Laser Diodes: Device Structure and Output Characteristics, Single Frequency Lasers; DFB, DBR Lasers, VCSEL, Quantum Well Laser, Quantum Cascade Laser, Micro-cavity lasers. Modulation of Laser Diodes, Practical Laser Diodes & Handling.	8
6	General Characteristics of Photodetectors, Impulse Response of Photodetectors. Photoconductors, Semiconductor Photo-Diodes, PIN diodes and APDs: Structure, Materials, Characteristics, and Device Performance. Photo-Transistors. Array Photodetectors: Quantum well infrared photodetectors (QWIP), CCD; Photomultiplier Tube, Thermal detectors, Solar cell.	9
7	Photonic Integrated Circuits - PICs; some examples and design issues.	3
8		
9		
10		
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		
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7		

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9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., 2nd Ed. (2007), Ch.16, 17, and 18.
2. G. Ghione, Semiconductor Devices for High-Speed Optoelectronics, Cambridge University Press (2009)
3. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1995).
4. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
5. G. Keiser, Optical Fiber Communications, McGraw-Hill Inc., 3rd Ed. (2000), Ch.4, 6.
6. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communication, Oxford University Press (2007), 6th Ed., Ch.15-17.

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	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre	Physics Department	
2.	Course Title (<45 characters)	Fiber Optic Components and Devices	
3.	L-T-P structure	3-0-0	
4.	Credits	3	
5.	Course number	PYL891	
6.	Status (category for program)	Program elective for JOP	
7.	Pre-requisites	PYL-791 or PYL-442 or an equivalent course in fiber optics	
8.	Status vis-à-vis other courses (give course number/title)		
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	PHL891	
9.	Not allowed for (indicate program names)		
10.	Frequency of offering	Every sem 1 st sem 2 nd sem Either sem: Either sem	
11.	Faculty who will teach the course	Profs. K. Thyagarajan, Arun Kumar, R. K. Varshney, M.R. Shenoy and Anurag Sharma	
12.	Will the course require any visiting faculty?		No
13.	Course objective (about 50 words): This course aims to explain the working principles of various in-line fiber optic components and sensors. There are a large number of fiber optic components used in various applications of fibers in communication and sensors. This course will lay the foundation for the understanding and designing of novel optical fiber optic components and sensors.		
14.	Course contents (about 100 words) (Include laboratory/design activities): Review of optical fiber properties: step and graded index fibers, multimode, single mode, birefringent, photonic crystal and holey fiber: Directional couplers: Analysis, fabrication and characterization: Fused and polished fiber couplers application in power dividers, wavelength division multiplexing, interleavers and loop mirrors: Fiber half-block devices and application in polarizers, and wavelength filters. Fiber grating: Short and Long period gratings, Analysis, fabrication and characterization: application in add-drop multiplexing, gain flattening, dispersion compensation and wavelength locking and sensing. Polarization effects in Optical fibers, Basic concepts of polarization, Fiber polarization components: Fiber optic wave-plates, polarization controllers and associated micro-optic components like isolators and circulators; Optical fiber sensors: Intensity, phase, polarization and wavelength-shift based sensors, applications in various disciplines.		
15.	Lecture Outline (with topics and number of lectures)		
Module no.	Topic		No. of hours
1	Review of optical fiber properties: step and graded index fibers, multimode, single mode, birefringent, photonic crystal and holey fiber:		3

2	Directional couplers: Analysis, fabrication and characterization: Fused and polished fiber couplers application in power dividers, wavelength division multiplexing, interleavers and loop mirrors:	8
3	Fiber half-block devices and application in polarizers, and wavelength filters.	3
4	Fiber grating: Short and Long period gratings, Analysis, fabrication and characterization:	6
5	Applications of fiber gratings in add-drop multiplexing, gain flattening, dispersion compensation and wavelength locking and sensing.	6
6	Polarization effects in Optical fibers, , Fiber polarization components: Fiber optic wave-plates, polarization controllers and associated micro-optic components like isolators and circulators;	8
7	Optical fiber sensors: Intensity, phase , polarization and wavelength-shift based sensors, applications in various disciplines	8
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

The tutorials will primarily be meant for clarification of doubts regarding individual problems or the basic concepts. No new material will be covered during these sessions.

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17. Brief description of laboratory activities :

Visits to the laboratory to demonstrate concepts discussed in the class will be undertaken.

18. Suggested texts and reference materials

1.	<i>Introduction to Fiber Optics</i> , Ajoy Ghatak and K Thyagarajan, Cambridge University Press, 1998. Reprinted by Foundation Books, New Delhi.
2.	<i>Guided Wave Optics, Selected Topics</i> , Ed. Anurag Sharma, Viva Books Private Limited, 2005
3.	<i>Polarization of light with application in optical fiber</i> ; Ajoy Ghtak and Arun Kumar,Tata McGraw Hill, New Delhi 2012.
4.	<i>Fundamentals of Optical Waveguides</i> , <u>K Okamoto</u> , Academic Press, 2006.

19. Resources required for the course (itemized & student access requirements, if any):
No special resources are required for the course.

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

Students will be given Assignments some of which will train the student in design of optical fibers, dispersion compensating fibers, fiber amplifiers etc.

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre	Physics Department	
2.	Course Title (<45 characters)	Fiber Optics	
3.	L-T-P structure	3-0-0	
4.	Credits	3	
5.	Course number	PYL791	
6.	Status (category for program)	Program Core for JOP	
7.	Pre-requisites	Nil	
8.	Status vis-à-vis other courses (give course number/title)		
	8.1 Overlap with any UG/PG course of the Dept./Centre	PYL442	
	8.2 Overlap with any UG/PG course of other Dept./Centre	NO	
	8.3 Supercedes any existing course	PHL791	
9.	Not allowed for (indicate program names)		NIL
10.	Frequency of offering	Every sem 1 st sem 2 nd sem Either sem: 1st sem	
11.	Faculty who will teach the course	Prof. K. Thyagarajan, Arun Kumar, Anurag Sharma, R. K. Varshney and M. R. Shenoy	
12.	Will the course require any visiting faculty?		No
13.	Course objective (about 50 words): This course on fiber optics will lay the foundation for understanding optical fiber communication and sensors. Fundamentals of wave guidance, and the role of attenuation and dispersion in limiting the information carrying capacity of the fibers will be discussed. Fiber amplifiers, fiber fabrication and characterization will also be covered.		
14.	Course contents (about 100 words) (Include laboratory/design activities): Rays and ray paths in optical fibers; Numerical aperture; Step index and graded index fibers; Attenuation in optical fibers; Modal analysis of symmetric planar waveguides; TE and TM modes, mode cut off, power flow: Linearly polarized (LP) modes in step-index optical fibers; Mode cutoff, single mode operation; Mode field diameter in single mode fibers, LP modes of infinitely extended parabolic medium, Intermodal dispersion in multimode fibers; Optimum profile fibers; Dispersion and chirping of pulses in single mode fibers, Dispersion compensation and dispersion tailoring; Birefringence in optical fibers, Polarization mode dispersion; Specialty fibers: Birefringent fibers, Photonic crystal fibers; Erbium doped fiber amplifiers and lasers; Fiber optic components: fiber Bragg gratings, directional couplers; Fiber fabrication and characterization techniques; OTDR, connectors and splices:		
15. Lecture Outline (with topics and number of lectures)			
Module no.	Topic		No. of hours
1	Rays and ray paths in optical fibers; Numerical aperture; Step index and graded index fibers; Attenuation in optical fibers;		4

2	Modal analysis of Symmetric planar waveguides; TE and TM modes, mode cut off, power flow:	5
3	Linearly polarized (LP) modes in step-index optical fibers; Mode cutoff, single mode operation; Mode field diameter in single mode fibers,	6
4	LP modes of infinitely extended parabolic medium, Intermodal dispersion in multimode fibers;, Optimum profile fibers;	3
5	Dispersion and chirping of pulses in single mode fibers, Dispersion compensation and dispersion tailoring;	6
6	Birefringence effects in optical fibers, Polarization mode dispersion; Specialty fibers: Birefringent fibers, Photonic crystal fibers	4
7	Fiber optic components: fiber Bragg gratings, directional couplers, Fiber optic wave-plates	5
8	Erbium doped fiber amplifiers and lasers	5
9	Fiber fabrication and characterization techniques; OTDR, connectors and splices:	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

17. Brief description of laboratory activities:

Visits to the laboratory to demonstrate concepts discussed in the class will be undertaken.

18. Suggested texts and reference materials

1.	<i>Introduction to Fiber Optics</i> ; Ajoy Ghatak and K Thyagarajan, Cambridge University Press, 1998. Reprinted by Foundation Books, New Delhi.
2.	<i>Polarization of light with application in optical fiber</i> ; Arun Kumar and A. K. Ghatak, Society of Photo Optical Engineers (SPIE), 2011
3.	<i>Optical Fiber Communication</i> , G. Keiser, McGraw Hill, 2000
4.	<i>Fundamentals of Photonics</i> , BMA Saleh and MC Teich, John Wiley, NY, 2007

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

No special resources, other than a projector which can be connected to a laptop in the class are required for the course.

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

Students will be given Assignments some of which will train the student in design of optical fibers, dispersion compensating fibers, fiber amplifiers etc.

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre	Physics Department	
2.	Course Title (<45 characters)	GUIDED WAVE PHOTONIC SENSORS	
3.	L-T-P structure	3-0-0	
4.	Credits	3	
5.	Course number	PYL892	
6.	Status (category for program)	Program Elective for JOP	
7.	Pre-requisites	PYL-791 / EPL-442 or any equivalent course in Fiber Optics	
8.	Status vis-à-vis other courses (give course number/title)		
	8.1 Overlap with any UG/PG course of the Dept./Centre	PYL-891	
	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)		
10.	Frequency of offering	Every sem 1 st sem 2 nd sem Either sem	
11.	Faculty who will teach the course	Profs. Arun Kumar, K. Thyagarajan, Anurag Sharma, M.R. Shenoy, R.K.Varshney	
12.	Will the course require any visiting faculty?		No
13.	Course objective (about 50 words): Guided wave photonic sensors are increasingly being used for sensing various physical parameters due their high sensitivity, immune to electromagnetic interference, possibility of miniaturisation, low cost and online monitoring. The objective of this course is to understand the basic concepts involved and the working principles of various guided wave photonic sensors. After going through this course one should be able to design and develop novel photonic sensors for various physical parameters.		
14.	Course contents (about 100 words) (Include laboratory/design activities): Review of propagation characteristics of single and multimode optical Fibers and Integrated optical Waveguides. Surface plasmon modes supported by a single metal/dielectric interface and dielectric/metal/dielectric waveguides. Fiber Optic Sensors: Intensity, phase, polarization and wavelength modulation schemes. Intensity based sensors: using microbends and tapers in multimode fibers, Mach-Zehnder interferometer sensors, Fiber Optic gyroscope, Fiber optic current sensor,, Photonic crystal based sensors. Sensors based on Bragg and Long period gratings in Fiber and integrated optical waveguides, Sensors based on modal interference: Applications in temperature, strain and refractive index sensing. Distributed Sensors based on Raman and Brillouin Scattering. Surface Plasmon Resonance (SPR) bio-sensors based on Krechman and Otto configurations, coupling with optical fiber modes, Grating coupled, Localised SPR, Plasmonic nanoparticles, interferometry. Signal processing, Noise		

15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Review of propagation characteristics of single and multimode optical Fibers and Integrated optical Waveguides.	4
2	Surface plasmon modes supported by a single metal/dielectric interface and dielectric/metal/dielectric waveguides.	2
3	Fiber Optic Sensors: Intensity, phase, polarization and wavelength modulation schemes. Intensity based sensors using microbends and tapers in multimode fibers, Mach-Zehnder interferometer sensors Fiber Optic gyroscope, Fiber optic current sensor,	10
4	Photonic crystal based sensors.	4
5	Sensors based on Bragg and Long period gratings in Fiber and integrated optical waveguides, Sensors based on modal interference: Applications in temperature, strain and refractive index sensing.	7
6	Distributed Sensors based on Raman and Brillouin Scattering.	4
7	Surface Plasmon Resonance (SPR) bio-sensors based on Kretschman and Otto configurations, coupling with optical fiber modes, Grating coupled, Localised SPR, Plasmonic nanoparticles, interferometry.	8
8	Signal processing, Noise factors in sensors.	3
9		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

The tutorials will primarily be meant for clarification of doubts regarding individual problems or the basic concepts. No new material will be covered during these sessions.

17. Brief description of laboratory activities :

Visits to the laboratory to demonstrate concepts discussed in the class will be undertaken.

18. Suggested texts and reference materials

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| 1. | <i>Introduction to Fiber Optics</i> , Ajoy Ghatak and K Thyagarajan, Cambridge University Press, 1998. Reprinted by Foundation Books, New Delhi. |
| 2. | <i>Fundamentals of Optical Fiber Sensors</i> , Z. Fang, K.K.Chin, R. Qu, H. Cai, Wiley, 2012, New Jersey, USA. |
| 3. | <i>Fiber Optic Sensors, An introduction for Engineers and Scientists</i> , Eric Udd and W. B. Spillman, 2nd Ed, Wiley, 2012, New Jersey, USA. |
| 4. | <i>Optical Fiber Sensors: Systems and Applications</i> , Ed. B. Culshaw and John Dakin, Artech House, Inc., 1989, Noewood, USA. |
| 5. | Photonic Crystals for Chemical Sensing and Biosensing. Fenzl, C., Hirsch, T. and Wolfbeis, O. S. <i>Angew. Chem. Int. Ed.</i> , 53 (2014) 3318–3335. |

19. Resources required for the course (*itemized & student access requirements, if any*):
No special resources are required for the course.

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

Students will be given Assignments some of which will train the student in design of optical fibers, dispersion compensating fibers, fiber amplifiers etc.

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre	Physics Department	
2.	Course Title (<45 characters)	Integrated Optics	
3.	L-T-P structure	3-0-0	
4.	Credits	3	
5.	Course number	PYL790	
6.	Status (category for program)	Program Elective for JOP	
7.	Pre-requisites	Nil	
8.	Status vis-à-vis other courses (give course number/title)		
	8.1 Overlap with any UG/PG course of the Dept./Centre	PYL442	
	8.2 Overlap with any UG/PG course of other Dept./Centre	No	
	8.3 Supercedes any existing course	PHL790	
9.	Not allowed for (indicate program names)		Nil
10.	Frequency of offering	Every sem 1 st sem 2 nd sem Either sem	
11.	Faculty who will teach the course	Profs. K.Thyagarajan, Arun Kumar, Anurag Sharma, R. K. Varshney and M.R. Shenoy	
12.	Will the course require any visiting faculty?		No
13.	Course objective (about 50 words): This is first course in integrated optics which will lay the foundation for understanding various integrated optical waveguides and devices used in optical communication and sensors.		
14.	Course contents (about 100 words) (Include laboratory/design activities): Guided TE and TM Modes of Symmetric and anti-symmetric Planar waveguides: Step-index and graded-index waveguides. Strip and channel waveguides, anisotropic waveguides, Marcatali's Method, Effective-Index method and perturbation method of analysis. Directional couplers, Coupled mode analysis of uniform and reverse delta-beta couplers. Applications as power splitters, Y-junction, optical switch; phase and amplitude modulators, filters, A/D converters, Y-splitters, Mode splitters, polarization splitters; Mach-Zehnder interferometer based devices, Acoustooptic waveguide devices. Arrayed waveguide devices, Nano-photonic-devices: Metal/dielectric plasmonic waveguides, Long and short range surface Plasmon modes supported by thin metal films, applications in waveguide polarizers and bio-sensing. Fabrication of integrated optical waveguides and devices. Waveguide characterisation, end-fire and prism coupling; grating and tapered couplers, Fiber pigtail, Nonlinear effects in integrated optical waveguides.		

15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Guided TE and TM Modes of Symmetric and anti-symmetric Planar waveguides :Step-index and graded-index waveguides	4

2	Strip and channel waveguides, anisotropic waveguides, Marcatili's Method, Effective-Index method and perturbation method of analysis.	6
3	Directional couplers, Coupled mode analysis of uniform and reverse delta-beta couplers. Applications as power splitters , Y-junction, optical switch; phase and amplitude modulators, filters, A/D converters; Y-splitters, mode splitters and polarization splitters, Mach-Zehnder interferometer based devices,	10
4	Acoustooptic waveguide devices.	3
5	Arrayed waveguide devices.	3
6	Nano-photonic waveguides, slot waveguides, Metal/dielectric plasmonic waveguides, Long and short range surface Plasmon modes, applications in waveguide polarizers and bio-sensing.	6
7	Fabrication of integrated optical waveguides and devices. Waveguide characterisation, end-fire and prism coupling; grating and tapered couplers, Fiber pigtailling.	6
8	Nonlinear effects in integrated optical waveguides.	4
COURSE TOTAL (14 times '3')		42

16. Brief description of tutorial activities:

The tutorials will primarily be meant for clarification of doubts regarding individual problems or the basic concepts. No new material will be covered during these sessions.

17. Brief description of laboratory activities: **None**

18. Suggested texts and reference materials

1.	<i>Optical Electronics</i> , A Ghatak and K Thyagarajan, Cambridge University Press, 1989.
2.	<i>Optical Integrated Circuits</i> ; H Nishihara, M Haruna and T Suhara, McGraw-Hill Book Company, New York, 1989.
3.	<i>Fundamentals of Optical waveguides</i> , K Okamoto, Academic Press, 2006 .
4.	<i>Integrated Optics</i> , ED. T. Tamir, Springer Verlag, New York, 1982.

19. Resources required for the course (itemized & student access requirements, if any):
No special resources are required for the course.

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

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre	Physics Department	
2.	Course Title (<45 characters)	Optical Electronics	
3.	L-T-P structure	3-0-0	
4.	Credits	3	
5.	Course number	PYL792	
6.	Status (category for program)	Program Core for JOP	
7.	Pre-requisites	Nil	
8.	Status vis-à-vis other courses (give course number/title)		
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	PHL792	
9.	Not allowed for (indicate program names)		NIL
10.	Frequency of offering	Every sem 1 st sem 2 nd sem Either sem: 2nd sem	
11.	Faculty who will teach the course	Prof M R Shenoy, Prof K Thyagarajan, Dr. Joyee Ghosh, Dr. Vijay Prakash	
12.	Will the course require any visiting faculty?		No
13.	Course objective (about 50 words): The course introduces the basic effects such as the electro optic and acousto optic effects used in modulation and switching of optical signals and the various nonlinear optical effects which find various applications in generation of new frequencies as well as in optical fiber communication systems.		
14.	Course contents (about 100 words) (Include laboratory/design activities): Light propagation through anisotropic media, Electro optic effect and electro optic modulators and switches, Liquid crystal devices and spatial light modulators, Acousto optic effect, acousto optic tunable filter, acousto optic deflector, scanner and spectrum analyser, Basics of nonlinear optical effects, Second harmonic generation, phase matching, quasi phase matching, Sum and difference frequency generation, parametric amplification and parametric oscillation, Third order nonlinear optical effects, Self phase modulation and soliton formation, Cross phase modulation and four wave mixing, Stimulated Raman and Brillouin scattering		

15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Light propagation through anisotropic media	6
2	Electro optic effect and electro optic modulators and switches	5
3	Liquid crystal devices and spatial light modulators	3
4	Acousto optic effect, acousto optic tunable filter, acousto optic deflector, scanner and spectrum analyzer	6
5	Basics of nonlinear optical effects	2

6	Second harmonic generation, phase matching, quasi phase matching	4
7	Sum and difference frequency generation, parametric amplification and parametric oscillation	6
8	Third order nonlinear optical effects, Self phase modulation and soliton formation	4
9	Cross phase modulation and four wave mixing	4
10	Stimulated Raman and Brillouin scattering	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Topic	No. of hours

17. Brief description of laboratory activities:

18. Suggested texts and reference materials

1.	<i>Optical Electronics</i> , Ajoy Ghatak and K Thyagarajan, Cambridge University Press, 1989
2.	<i>Photonics</i> , A Yariv and P. Yeh, Oxford Univ. Press, 2007.
3.	<i>Fundamentals of Photonics</i> , BMA Saleh and MC Teich, John Wiley, NY, 2007
4.	<i>Nonlinear Optics</i> , Robert W. Boyd, Academic Press is an imprint of Elsevier, 2008
5.	<i>Nonlinear Fiber Optics</i> , G P Agarwal, Academic Press, Boston, 2013
6.	<i>Introduction to fiber optics</i> , A Ghatak and K Thyagarajan, Cambridge Univ. Press, UK, 1998

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

Nothing special

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

Assignments will be given to the students. Some of them would have design component; this could include design of electro optic modulators, acousto optic devices, parametric amplifiers etc.

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre	Physics Department	
2.	Course Title (<45 characters)	Optics and Lasers	
3.	L-T-P structure	3-0-0	
4.	Credits	3	
5.	Course number	PYL795	
6.	Status (category for program)	Program Elective	
7.	Pre-requisites	Nil	
8.	Status vis-à-vis other courses (give course number/title)		
8.1	Overlap with any UG/PG course of the Dept./Centre	PYL115, PYL334, PHL558, PHL655	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	PHL795	
9.	Not allowed for (indicate program names): not allowed for students who have done the mentioned courses.		
10.	Frequency of offering	Every sem 1 st sem 2 nd sem Either sem: Ist sem	
11.	Faculty who will teach the course	Profs. R. K. Varshney, Anurag Sharma, M. R. Shenoy, Arun Kumar and K. Thyagarajan	
12.	Will the course require any visiting faculty?	No	
13.	Course objective (about 50 words): This course will serve as a bridge course for those students, who do not have sufficient knowledge of optics, optical devices, lasers, and laser systems.		
14.	Course contents (about 100 words) (Include laboratory/design activities): Review of basic optics: Reflection and refraction of plane waves; Polarization and polarizing devices; Diffraction: diffraction due to single slit and circular aperture, grating, Gaussian beam; Interference: two beam and multiple beam interference, Fabry-Perot interferometer, Michelson interferometer; Fourier optics and its applications, spatial frequency filters; Interaction of light with matter, light amplification and oscillation, Laser rate equations, three level and four level systems, Line broadening mechanisms and Laser power around threshold, Optical resonators and resonator stability, Modes of a spherical mirror resonator, mode selection, Q-switching, mode locking in lasers, properties of laser radiation, laser systems and some applications of lasers.		
15. Lecture Outline (with topics and number of lectures)			
Module no.	Topic	No. of hours	
1	Reflection and refraction of plane waves	3	
2	Light propagation through anisotropic media and Polarizing devices	4	

3	Diffraction due to single slit and circular aperture, grating, Diffraction of Gaussian beam	6
4	Interference: two beam and multiple beam interference, Michelson interferometer, Fabry-Perot interferometer	5
5	Fourier Optics and its applications in spatial frequency filtering	4
6	Interaction of light with matter, light amplification, Laser rate equations, three level and four level systems, Line broadening mechanisms	9
7	Optical resonators and resonator stability, modes of a spherical mirror resonator, mode selection, and Laser power around threshold	6
8	Q-switching and mode locking in lasers	3
9	Some laser systems	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Topic	No. of hours
	Problems related to each topic will be discussed in the class itself as the course proceeds.	

17. Brief description of laboratory activities:

Students will be taken to the laboratory to demonstrate some of the devices covered in the course.

18. Suggested texts and reference materials

1.	<i>Optics (5th Ed.)</i> , Ajoy Ghatak, Tata McGraw-Hill Publications, 2012,
2.	<i>Fundamentals of Photonics</i> , BMA Saleh and MC Teich, John Wiley, NY, 2007
3.	<i>Optical Electronics</i> , A Ghatak and K Thyagarajan, Cambridge University Press, 1989
4.	<i>Lasers: Fundamentals and Applications</i> (2nd ed.), K Thyagarajan and A. K. Ghatak, Springer Science & Business Media, 2010
5.	<i>Optics</i> , Eugene Hecht, Pearson Education, 2005

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

Nothing special

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

Assignments will be given to the students. Some of them would have design component

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	ELECTRICAL ENGINEERING	
2.	Course Title <i>(< 45 characters)</i>	Computational Electromagnetics	
3.	L-T-P structure	3-0-0	
4.	Credits	3	
5.	Course number	ELL724	
6.	Status <i>(category for program)</i>	Program Elective for JOP, EEE	

7.	Pre-requisites <i>(course no./title)</i>	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		
	8.2 Overlap with any UG/PG course of other Dept./Centre		
	8.3 Supersedes any existing course	EEL766	

9.	Not allowed for <i>(indicate program names)</i>	
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☒ Either sem -
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11.	Faculty who will teach the course: Dr. Uday Khankhoje, Dr. Kushal Shah, Dr. Anuj Dhawan
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives <i>(about 50 words):</i> To understand contemporary techniques of computation in electromagnetism to (a) build simulation tools, and (b) analyse and interpret the working of existing software tools.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Review of vector calculus, review of electromagnetism, advanced concepts in EM: Uniqueness, reciprocity, reaction, volume equivalence, surface equivalence (Huygen's theorem), image theory, finite difference time domain method (FDTD), frequency domain eigen solutions of Maxwell's equations for periodic structures, finite element method (FEM), integral equation methods and the method of moments (MoM), geometric theory of diffraction (GTD), numerical methods of solving matrix equations.
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15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
1	Overview of methods in computational electromagnetics	2
2	Review of electromagnetism and vector calculus	2
3	Advanced concepts in electromagnetism	3
4	Finite difference time domain methods	10
5	Finite element methods in Electromagnetics	8
6	Integral equation methods in Electromagnetics	8
7	Band-structure calculations for periodic dielectric materials	4
8	Geometric theory of diffraction	2
9	Numerical issues in implementation	3
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities: N/A

17. Brief description of laboratory activities : N/A

18. Suggested texts and reference materials

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

1. Peterson A F, Ray S L, Mitra R; Computational Methods for Electromagnetics; 1st edition; IEEE Press, 1997.
2. Volakis J L, Chatterjee A, Kempel L C; Finite Element Method Electromagnetics: Antennas, Microwave Circuits, and Scattering Applications; 1st edition, IEEE Press, 1998.
3. Chew W C, Tong M S, Hu B; Integral Equation Methods for Electromagnetic and Elastic Waves; 1st edition; Morgan & Claypool Publishers, 2007.
4. Joannopoulos J D, Johnson S G, Winn J N, Meade R D; Photonic Crystals: Molding the Flow of Light; 2nd edition, Princeton University Press, 2008.
5. Rylander, Ingelström, Bondeson; Computational Electromagnetics; 2nd edition, Springer, 2013.
6. Taflov A and Hagness S C; Computational Electrodynamics: The Finite-Difference Time-Domain Method, 3rd ed., Artech House Publishers, 2005.

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

19.1	Software	NIL
19.2	Hardware	NIL
19.3	Teaching aides (videos, etc.)	NIL
19.4	Laboratory	NIL
19.5	Equipment	NIL
19.6	Classroom infrastructure	Basic infrastructure
19.7	Site visits	NIL
19.8	Others (please specify)	NIL

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

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

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Introduction to Plasmonics
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL819
6.	Status (<i>category for program</i>)	Program Elective (PE) for JOP

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)	N/A
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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. Kushal Shah, Dr. Anuj Dhawan	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): The motivation for the course is to give an introduction to plasmonics and related areas.
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): EM Waves, Maxwell's Equations, Origin of Permittivity, Evanescent Waves, Surface Plasmons, Scattering and Diffraction, Spoof Surface Plasmon, Extraordinary Optical Transmission, Numerical Simulations of Surface Plasmons, Negative Index Materials.
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1.	Basics of Electromagnetics	2
2.	Origin of Permittivity	2
3.	Evanescent Waves	2
4.	Surface Waves in Dielectrics	3
5.	Surface Plasmons on Single Interface	2
6.	Surface Plasmons on Multiple Interfaces	3
7.	Excitation of Surface Plasmons	3
8.	Localized Surface Plasmon Resonance	3
9.	Scattering and Diffraction	3
10.	Spoof Surface Plasmon	6
11.	Extraordinary Optical Transmission	3
12.	Numerical Simulation of Surface Plasmons	6
13.	Negative Index Materials	4
COURSE TOTAL (<i>14 times 'L'</i>)		42

16. Brief description of tutorial activities - None**17. Brief description of laboratory activities** – None**18. Suggested texts and reference materials**

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

S. Maier, Plasmonics - Fundamentals and Applications, First Edition, Springer, 2007

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

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

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

20.1	Design-type problems	
20.2	Open-ended problems	10%
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)