Programme Name/s	**: Digital Electronics/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/ Electronics & Computer Engg.**
Programme Code	**: DE/ EJ/ EK/ ET/ EX/ IE/ TE**
Semester	**: Sixth**
Course Title	**: OPTICAL NETWORK AND SATELLITE COMMUNICATION**
Course Code	**: 316332**

I. RATIONALE

Optical networks and satellite communication are the backbone of all high speed communications. The optical networking and satellite communication course is crucial for driving innovative technologies across multiple sectors. This course has been designed to empower diploma engineering students to maintain fiber optics and satellite communication systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attend the following industry/employer expected outcome through various teaching learning experiences.

Maintain optical and satellite communication systems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret the functions of the various units of optical fiber communication system.
- CO2 - Evaluate the performance characteristics of optical sources and detectors.
- CO3 - Establish analog and digital fiber optic link.
- CO4 - Analyze various parameters influencing performance of transmitted and received signals in satellite communication systems.
- CO5 - Maintain Satellite earth segment.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316332	OPTICAL NETWORK AND SATELLITE COMMUNICATION	ONS	DSC	4	-	4	2	10	5	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Interpret the Electromagnetic Magnetic Spectrum and spot the optical bands used for optical fiber communication. TLO 1.2 Describe the functions of each block in fiber optic communication system. TLO 1.3 Define the given basic optic terms. TLO 1.4 Classify the optical fiber cables based on modes of propagation of light and index profile TLO 1.5 Describe fiber joints, fiber connectors and splices. TLO 1.6 Describe step by step splicing procedure.	**Unit - I Basics of Optical fiber communication** 1.1 Electromagnetic spectrum, optical bands and optical windows, need for optical fiber communication. 1.2 Construction, advantages ,disadvantages and applications of fiber optic cable ,block diagram of optical fiber communication system. 1.3 Definition-Reflection, Refraction, Total Internal Reflection (TIR),Snell's law, Critical angle, Numerical Aperture (NA) , Acceptance angle and Acceptance cone , Light propagation in optical fiber–(Numerical on above concepts) 1.4 Classification of optical fibers-based on modes of propagation of light and index profile, Propagation modes-single mode, multi mode ,mode-field diameter in single-mode optical fiber (SMF) 1.5 Fiber joints, fiber connectors, splices 1.6 Splicing Techniques-Fusion splice,V-groove splice and elastic tube splice	Presentations Video Demonstrations Lecture Using Chalk-Board

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Describe working principle and characteristics of given optical source. TLO 2.2 Describe the working principle and characteristics of the given optical detector. TLO 2.3 Explain the coherent detection technique used in optical receivers. TLO 2.4 Describe the working of the given optical network component. TLO 2.5 Compare the working of optical amplifiers.	**Unit - II Optical Communication Systems** 2.1 Working principle and characteristics of sources: Edge emitting Light Emitting Diode, Edge emitting Light Amplification by Stimulated Emission of Radiation 2.2 Working principle and characteristics of detectors : PIN photodiode , Avalanche photo diode, Comparison of PIN photodiode and Avalanche photo diode 2.3 Eye diagram, BER ,Q -Factor and Coherent detection in optical receivers 2.4 Couplers, isolators, circulators, Optical routers 2.5 Basic applications and types of optical amplifiers: Erbium -Doped Fiber Amplifiers, Raman Amplifiers, features of Optical network Ethernet standards : IEEE 802.3j,802.3y,802.3z	Lecture Using Chalk-Board Presentations
3	TLO 3.1 Explain dispersion in optical fibers. TLO 3.2 Describe dispersion management and compensation techniques for improved transmission. TLO 3.3 Illustrate the effect of pulse spreading on signal transmission. TLO 3.4 Describe the transmission losses in the optical fiber cable. TLO 3.5 Describe the steps to measure optical parameters using OTDR. No Numerical.	**Unit - III Characteristics of Optical Fiber** 3.1 Dispersion in Optical fiber, types of dispersion 3.2 Dispersion compensation techniques , dispersion measurements - Chromatic Dispersion, Group Velocity Dispersion, Dispersion Slope, Polarization Mode Dispersion 3.3 Pulse spreading and its impact on signal transmission 3.4 Transmission losses in the optical fiber- Insertion loss, Return loss, dispersion loss, coupling loss, attenuation loss, absorption losses, radiation losses and linear scattering losses 3.5 Link power budget, Optical Time Domain Reflectometer (OTDR)-Working Principle.	Lecture Using Chalk-Board Demonstration Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Describe the types of satellites and their respective functions. TLO 4.2 Explain the phenomenon of limits of visibility and Sun Transit Outage. TLO 4.3 Define the given key satellite communication terms-(latitude, longitude, look angle, elevation angle, station keeping, propagation delay, velocity, and footprint). TLO 4.4 Describe Kepler's law of satellite motion.	**Unit - IV Overview of Satellite Systems** 4.1 Block diagram of Satellite Communication system, Earth segment , Different types of satellites-Active, Passive, geostationary and geosynchronous, Frequency allocation for satellite services-uplink and downlink frequency, Satellite frequency bands 4.2 Different satellite orbits-Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Elliptical Orbit, Geostationary Earth Orbit (GEO) and their comparison , limits of visibility and Sun Transit Outage. 4.3 Basic terminologies used in satellite communication-latitude, longitude ,look angle, elevation angle, station keeping, propagation delay time, velocity and footprint (numerical on Look Angle) 4.4 Kepler's law of satellite motion (three laws), apogee and perigee heights, orbital perturbations, effects of a nonspherical earth shape, atmospheric drag, effect of eclipse on satellite motion.	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations Hands-on Case Study Site/Industry Visit
5	TLO 5.1 Explain the roles and operations of the subsystem in the satellite earth station. TLO 5.2 Describe various satellite link transmission losses. TLO 5.3 Compute different parameters related to satellite communication using the link power budget analysis. TLO 5.4 Describe the working of the VSAT with the help of a suitable block diagram.	**Unit - V Satellite space segment and space link** 5.1 Block Diagram of Satellite Earth Station, Antenna subsystem,Low Noise Amplifier (LNA),Power subsystem, Telemetry Tracking and Control (TT & C) system, Power Supply subsystem, Attitude Control, Spinning satellite stabilization, Momentum wheel stabilization, Thermal control, Main and auxiliary propulsion subsystem, Transponders:-Single ,double conversion and regenerative type, wideband receiver, input demultiplexer, power amplifier 5.2 Equivalent Isotropic Radiated Power (EIRP), Transmission Losses : Free- space transmission loss, Feeder losses, Antenna misalignment losses, Fixed atmospheric and ionosphere losses, PC- PC communication using Satellite Link , rain attenuation 5.3 Link-Power Budget, System Noise, Carrier-to-Noise Ratio, Combined Uplink and Downlink C/N Ratio, Reliability in satellite System 5.4 Satellite Applications: GPS, VSAT, Meteorology applications.	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations Hands-on Case Study Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify optical components, cables.	1	* Identification of optical components and cables.	2	CO1
LLO 2.1 Identify core, cladding, and coating of optical fiber.	2	Identification of core,cladding and coating of optical fiber cable.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Measure numerical aperture of optical fiber to find the refractive index.	3	* Find numerical aperture of optical fiber.	2	CO1
LLO 4.1 Test the performance of an Avalanche Photodiode (APD).	4	* Test the performance of an Avalanche Photodiode (APD) (Virtual lab can be used in case of non- availability of instruments in the lab)	2	CO2
LLO 5.1 Evaluate the Performance of the given photodiode (detector) using LED as an Optical Source	5	* Analysis of Photodiode Characteristics (Virtual lab can be used in case of non-availability of instruments in the lab)	2	CO2
LLO 6.1 Test the performance of the given photo-diode (Detector) using LASER as an optical source	6	* Measurement of light intensity and photocurrent at various positions for a given photodiode	2	CO2
LLO 7.1 Measure bit error rate (BER) at the optical receiver.	7	Find the bit error rate (BER) at the optical channel receiver.	2	CO2
LLO 8.1 Measure various parameters of the observed eye pattern.	8	* Measurement of various parameters of eye pattern.	2	CO2
LLO 9.1 Measure the power and find the attenuation loss in the given length of optical fiber cable.	9	Measurement of attenuation loss in optical fiber.	2	CO3
LLO 10.1 Measure the bending loss in optical fiber.	10	* Measurement of bending loss of given optical fiber cable.	2	CO3
LLO 11.1 Measure optical power using optical meter.	11	Measurement of optical power using optical meter	1	CO3
LLO 12.1 Calculate the Link Power Budget as per equation.	12	* Computation of Link Power Budget for Fiber Optics Using Coding (Use open source simulation software).	2	CO3
LLO 13.1 Determine the rise time budget.	13	* Computation of rise time budget w.r.t fiber optics through coding (Use open source simulation software).	2	CO3
LLO 14.1 Test satellite link operations.	14	* Establishing an Active satellite link and demonstrating link failure operations	2	CO4
LLO 15.1 Create a direct communication link between the Uplink Transmitter and Downlink Receiver using a tone signal .	15	Establish a direct communication link between the Uplink Transmitter and the Downlink Receiver using a tone signal.	2	CO4
LLO 16.1 Establish audio video satellite link between transmitter and receiver	16	Establishing audio video satellite link between transmitter and receiver	2	CO4
LLO 17.1 Establish a link to transmit and receive three separate signals (Audio, Video, Tone).	17	Simultaneous Transmission and Reception of Audio, Video, and Tone/Voice Signals via Satellite Link	2	CO4
LLO 18.1 Test the performance of satellite link by sending telecommand and receive the telemetry Data	18	Evaluating satellite link performance by transmitting telecommands and receiving telemetry data.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 19.1 Interpret the result of the satellite link signal using function generator.	19	Transmission and reception of function generator waveforms through satellite communication link.	2	CO4
LLO 20.1 Estimate satellite Look Angles (Azimuth & Elevation) through coding.	20	* Calculation of Satellite Look Angles (Azimuth & Elevation) Using Coding (Use open source simulation software).	2	CO4
LLO 21.1 Verify Kepler's laws of motion	21	Simulating and validating Kepler's laws of planetary motion using code.(Use any relevant open source software).	2	CO4
LLO 22.1 Estimate Satellite Eclipse Periods	22	Simulation of Satellite Eclipse Periods through coding.(Use open source simulation software).	2	CO4
LLO 23.1 Measure carrier-to-noise ratio (C/N) of established satellite link.	23	* Measurement of the carrier-to-noise ratio (C/N) of the established satellite link.	2	CO5
LLO 24.1 Use RS 232 ports to set up a PC-PC satellite communication link	24	* Establish a direct communication link between two PCs using RS-232 serial ports.	2	CO5
LLO 25.1 Estimate rain attenuation through simulation.	25	* Find rain attenuation through coding (Use open source simulation software).	2	CO5
LLO 26.1 Investigate satellite link budget.	26	* Simulation of satellite link budget through coding (Use open source simulation software).	2	CO5
LLO 27.1 Test the reliability of satellite system.	27	Analysis of reliability in satellite system.	2	CO5
LLO 28.1 Calculate EIRP of any given satellite communication link.	28	* Find EIRP or any given satellite communication link through coding.(Use open source simulation software).	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- The orbit of an earth orbiting satellite has an eccentricity of 0.15 and a semimajor axis 9000 km, determine the apogee. [Assume the earth's radius as 6371 km].
- A fiber has a core diameter of 2 micro meter and its core refractive index is 1.43. The refractive index of cladding is 1.415. Determine : (i) numerical aperture (ii) critical angle (iii) Acceptance angle (iv) Relative refractive index difference.

Student Activities

- Prepare a survey report to compare the technical specifications of different types of optical sources and detectors.
- Prepare a report on splicing techniques used in industry or telecom service providers.
- Prepare the chart to indicate applications of various satellite frequency bands (L,S,C,X,Ku,Ka band).
- Conduct an Internet survey and prepare a detailed report on GPS and its applications.

Visit

- Visit a facility where fiber optics are utilized for communication and various applications ,such as institute LAN, computer networking, remote sensing, the automotive industry, healthcare, decorations and lighting, telecommunication, cable television, mechanical inspections and prepare a report.
- Visit a satellite center or pool lab equipped with a satellite setup and compile a detailed report on its components and their functions.

Micro project

- Build fiber optic lamp to demonstrate total internal reflection and light dispersion.
- Develop a GPS-based speedometer.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Splicing,Cutting and trimming tool of plastic fiber optics cables	1,2,9,10,11
2	Fiber optic cleaning kit	1,2,9,10,11
3	Fiber optic cables	1,2,9,10,11
4	Fiber optic Trainer kit	1,3,7,8,9,10,11
5	Optical fiber power meter	11
6	Desktop computer/Laptop,List of software:MATLAB,SCILAB or any other open source software	12,13,20,21,22,25,26,27,28
7	Spectrum Analyzer-frequency range-2.4 to 2.495 GHzResolution-26 KHz to 3 MHz,resolution BW-58.036 to 812.500 KHz	14,15,16,17,18,19,23
8	Satellite Trainer Kit (ST2272)/(STC 24):Uplinking frequency 2414/2432/2450/2468 MHz,4 MHz clock frequency,PIC16F84-8 bit RISC processor based PLL,16 MHz Bandwidth,FM Modulation of Audio and Video 5/5.5/8 MHz Audio and Video Modulation,Detachable Dish Antenna,Radiated Power output 25mW (approx.),4 downlink frequencies 2414/2432/2450/2468 MHz	14,15,16,17,18,19,23
9	RF Signal Generator,9 KHz to 3 GHz,Output Power @ 1 GHz,-127 dBm to +13 dBm AM,FM,PM Analog I/Q Input Pulse,Frequency Modulation-Maximum Deviation @ 1 GHz,20 Hz to 100 KHz	19
10	PC-Processor-dual core @ 2.4 GHz(i5 or i7 Intel processor or equivalent AMD),RAM-4GB,Hard Drive-320 GB 5400 RPM hard drive,OS-win 7/10	24

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
11	DMM:DC,0-1.5/3 Amp,0-2.5/5 Amp,0-5/10 Amp,0-150/300V,0-250/500V,0-75/150VAC-0-1000V,0-10A	4,5,6
12	Fiber optic cable Tester	4,5,6
13	Lux meter:Display:3 1/2 digit 18mm (0.7")/LCDRanges:1 to 50,000 LUX/Over -input:indication of	4,5,6
14	Power Supply Type:DC,0-30 V, 0-3 A	4,5,6,9,10,11
15	OTDR-Attenuation resolution -0.001BdB,Attenuation measurement linearity 0.05 dB ,Distance measurement accuracy +/- (0.5 + resolution + 5 X 10-5 X L) m	9
16	CRO/Digital storage oscilloscope:60 MHz/100 MHz/200 MHz bandwidth,500MS/s to 1 GS/s real -time sample rate,50 GS/s sample rate for repetative waveforms,High resolution color LCD display	9,10

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Optical fiber communication	CO1	10	2	4	6	12
2	II	Optical Communication Systems	CO2	10	2	6	6	14
3	III	Characteristics of Optical Fiber	CO3	15	4	6	6	16
4	IV	Overview of Satellite Systems	CO4	10	2	4	6	12
5	V	Satellite space segment and space link	CO5	15	2	6	8	16
Grand Total				**60**	**12**	**26**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be considered for out of 30 marks.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks. End semester summative assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

OPTICAL NETWORK AND SATELLITE COMMUNICATION **Course Code : 316332**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	2	3	2	2	3			
CO2	3	2	2	3	2	2	1			
CO3	2	1	3	2	1	2	2			
CO4	3	2	3	3	1	1	3			
CO5	1	3	2	1	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Kieser, Gerd	Fiber Optic Communication	Mc Graw Hill Higher Education, New Delhi ,2013, ISBN: 9781259006876,
2	Roddy Dennis	Satellite Communications	Tata McGraw-Hill, New Delhi, fourth edition ,2017 ISBN-13: 978-0070077850
3	G Agrwal	Fiber optic communication System	John Wiley and Sons, New York ,ISBN: 978-1-119-73736-0.
4	Biswanath Mukherjee	Optical Communication Networks	McGraw-Hill,ISBN-13. 978-0070444355
5	Katiyar,Sapna	Satellite Communication	Katson publications,3rd edition 2013,ISBN-978-93-5014-481-7
6	Rao Raja K.N.	Satellite Communication concepts and applications	PHI learning Private limited,New Delhi,second edition 2012,ISBN-978-81-203-4725-0

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=oIurmHsRFSc	NPTEL sessions IIT Mumbai
2	https://oc-iitr.vlabs.ac.in/List%20of%20experiments.html	Virtual Lab for optical communication
3	https://www.youtube.com/watch?v=ougKUUM3hJA&list=PLHj96QRJ0kOhH8xoXXrOgkMf9ZOvjhqY1	NPTEL-NOC IITM video: Fiber Optic Communication Technology
4	https://www.youtube.com/playlist?list=PLgwJf8NK-2e7CDIWsh61eItP9iRw1EIQc	Optical Fiber Communication
5	https://www.youtube.com/watch?v=tu9mW6U6Xmc	NPTEL sessions IIT Mumbai
6	https://www.youtube.com/watch?v=Lis3Bk_guEM	NPTEL sessions IIT Mumbai

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Sr.No	Link / Portal	Description
7	https://www.youtube.com/playlist?list=PL3rE2jS8zxAxamj-MY7FvzOZkHUALNndQ	Satellite Communication Videos
8	https://youtu.be/n2VeCHetC0I	Simulation of Photodiode
9	https://youtu.be/dZsXqJrZDOQ?si=BWR9hNXMifA44O4r	Bending loss and attenuation loss measurement in optical communication
10	https://youtu.be/jvLmcbxouB4?si=KW-7AUH8x3y9ZZ5l	Measurement of Numerical Aperture
11	https://youtu.be/x0SCzP9mt3c?si=Oh0HSXikOM9GWKhl	Determination of the acceptance angle and numerical aperture of a given optical fiber
12	https://youtu.be/bMgU3N1Vuvc?si=n9tx1V8x5DyS2YQc	Measurement of attenuation loss in optical fiber
13	https://youtu.be/4MYfxlVoUoQ?si=H-dVoo9Sw9k58cMG	Measurement of bending loss in optical fiber
14	https://youtu.be/GP39QVYwmNU?si=2AnM1ieV-Dwbj7Iv	How to Read an OTDR Trace - from Corning Cable Systems
15	https://youtu.be/xba2MThR9Ls?si=fr3rgi6om8dYvoXb	Fiber Optic Splicing Guide & Demo
16	https://www.youtube.com/watch?v=oPCmLD3LQk0	Scientech 2272A Satellite Communication Trainer Kit DEMO

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students