STATE BOARD OF TECHNICAL EDUCATION, BIHAR

Scheme of Teaching and Examinations for

4th SEMESTER DIPLOMA IN FIRE TECHNOLOGY AND SAFETY

(Effective from Session 2022-23 Batch)

THEORY

Sr. No.	SUBJECTS	SUBJECT CODE	TEACHING SCHEME	EXAMINATION – SCHEME							Credits
			Periods per Week	Hours of Exam.	Teacher's Assessment (TA) Marks (A)	Class Test(CT) Marks (B)	End Semester Exam. (ESE) Marks(C)	Total Marks (A+B+C)	Pass Marks ESE	Pass Marks in the Subject	
1.	Fire Service Hydraulics	2048401	04	03	10	20	70	100	28	40	04
2.	Fire Dynamics	2048402	03	03	10	20	70	100	28	40	03
3.	Heat Transfer Operation	2048403	03	03	10	20	70	100	28	40	03
4.	Structural Fire Protection	2048404	03	03	10	20	70	100	28	40	03
5.	Fire Suppression Systems	2048405	03	03	10	20	70	100	28	40	03
		Total:- 16					**350**	**500**			**16**

PRACTICAL

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME					
			Periods per Week	Hours of Exam.	Practical (ESE)		Total Marks (PA+ESE)	Pass Marks in the Subject	Credits
					Internal (PA)	External (ESE)			
6.	Electrical Workshop Fire Protection Lab.	2048406	04 50% physical 50% Virtual	03	15	35	50	20	02
7.	Pumping Machinery & Fluid Mechanics Lab	2048407	02 50% physical 50% Virtual	03	15	35	50	20	01
8.	Fire Fighting And Field Training-II	2048408	04 50% physical 50% Virtual	03	15	35	50	20	02
Total: - 10							**150**		**05**

TERM WORK

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME				
			Periods per Week	Marks of Internal Examiner (PA)	Marks of External Examiner (ESE)	Total Marks (PA+ESE)	Pass Marks in the Subject	Credits
9.	Minor Project	2048409	03	15	35	50	20	01
10.	Course Under Moocs/Swayam/Other	2048410	04	15	35	50	20	02
Total: - 07						**100**		**03**
Total Periods per week Each of duration One Hour 33			Total Marks = **750**					**24**

FIRE SERVICE HYDRAULICS

Subject Code 2048401	Theory			No of Period in one session : 56			Credits
	No. of Periods Per Week			Full Marks	:	100	04
	L	T	P/S	ESE	:	70	
	04	—	—	TA	:	10	
				CT	:	20	

Rationale:

Hydraulics is a branch of science that deals with the flow of water through the pipes and hydraulic machines. It is a difficult and important subject and very interesting if one has clearly understood the basic laws governing the flow.

Course outcomes:

After completion of this course student will be able to:

1. Understand the principle of pressure in non-flowing water system
2. Apply the knowledge of hydraulics to fire protection Engineering
3. Calculate Sprinkler system Demand

Contents : Theory		Hrs
Unit -1	Water Supply Analysis Overview - Define "hydraulics" as it applies to fire protection Engineering,types of water supply.	[10]
Unit -2	Basic Principles of Hydraulics - Recognize and apply the basic principles of pressure in a non-flowing water system, Recognize and apply the basic principles of water flow in a piping system and through an orifice, Concept of friction loss and determine friction loss.	[14]
Unit -3	Calculating Sprinkler System Demand: Simple Side-Fed Tree, Generally describe the interaction between flow and pressure in an operating sprinkler system and identify mathematical relationships that are the basis of sprinkler system calculations, Demonstrate the relationship between flow and pressure by using pressure balancing in performing head by head calculations for a simple-side-fed tree sprinkler system.	[16]
Unit -4	Hydraulics of Water Supplies for Automatic Sprinkler Systems	[04]
Unit -5	Concepts - Bernoulli's Theorem and Applications, Hazen-Williams Formula, Pressure Loss at Fittings, Discharge from Nozzles, Discharge Coefficient, Theoretical Discharge.	[12]
	Total	**56**

Books Recommended:-

1. Loss Prevention Datasheet by FM Global, FMDS3-0.
2. SFPE Hand Book for Fire Protection Engineering ,NFPA
3. Fire Service Hydraulics: Questions and Answers by Dick Sylvia
4. Simplified Fire Department Hydraulics by Frederick Shepperd
5. NFPA Codes & Standards

FIRE DYNAMICS

Subject Code	Theory			No of Period in one session : 42			Credits
2048402	No. of Periods Per Week			Full Marks	:	100	
	L	T	P/S	ESE	:	70	03
	03	—	—	TA	:	10	
				CT	:	20	

Rationale:

Fire Dynamics is the study of how chemistry, fire science, material science and the mechanical engineering disciplines of fluid mechanics and heat transfer interact to influence fire behavior. In other words, Fire Dynamics is the study of how fires start, spread and develop.

Course Outcomes :-

After completion of this course student will be able to:-

1. Define fire growth and energy release rate from fire burning
2. Survey various places which are venerable to fire
3. Perform Classify Compartmental zone fires
4. Remember various codes, standards and laws related to fire

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Contents : Theory		Hrs
Unit -1	**Combustion fundamentals** Chemical Thermodynamics and kinetics, Pyrolysis, ignition and combustion, conservation equations for mass, momentum, energy and species, turbulence, radiation.	[10]
Unit -2	**Survey of applications** Industrial settings, buildings, transport modes, forest, samiyana, ghuggi-jhopri, materials and their properties, inventory of combustible materials.	[06]
Unit -3	**Fire dynamics** Flames and fire spread theory, buoyant plumes, interactions with surfaces, smoke spread, turbulent and radiation effects, toxic products; feedback to fuel; fire chemistry, nitrogen.	[10]
Unit -4	**Compartment zone fires** Flashover, post-flashover, control, applications.	[06]
Unit -5	**Codes, standards and laws** Case studies of real fires – buildings, factories and god owns, automobiles, buses, trains and aircraft, oil spills, forest fires, tents, slums, residential spaces. Engineering evaluation of fire safety.	[10]
	Total	**42**

Books Recommended:-

1. Drysdale, D.D., An Introduction to Fire Dynamics, Wiley, New York, 1999.
2. Lyons, J.W., Fire, Scientific American Books, New York.
3. Karlsson, B., and Quintiere, J.G., Enclosure Fire Dynamics, CRC Press.
4. Cox, G., Combustion Fundamentals of Fire, Academic Press, London, 1995.
5. Haessler, W.M., Fire: Fundamentals and Control, Marcel Dekker, 1988.
6. SFPE, Handbook of Fire Protection Engineering, NFPA, Quincy, Mass.
7. Quintiere, J.G., Principles of Fire Behavior, Delmar, 1985.

HEAT TRANSFER OPERATION

Subject Code 2048403	Theory			No of Period in one session : 42			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
				CT	:	20	

Rationale:

Heat transfer is a process is known as the exchange of heat from a high-temperature body to a low-temperature body. As we know heat is a kinetic energy parameter, included by the particles in the given system. As a system temperature increases the kinetic energy of the particle in the system also increases.

Course Outcomes:

At the end of the course, Student will be able to

1. Impart an introductory treatment of the governing laws of Convection heat transfer
2. Formulate & reduce mass, momentum and energy conservation equations according to then physical situation involved.
3. Obtain exact and approximate solutions of external and internal boundary layer flow problem

Contents : Theory		Hrs
Unit -1	**Introduction:-** Various modes of heat transfer, Fourier's, Newton's and Stefan Boltzmann's Law, Combined modes of heat transfer, Thermal transfer, Thermal diffusivity, Overall heat transfer coefficient.	[04]
Unit -2	**Conduction:-** The thermal conductivity of solids, Liquids and gases, Factors influencing conductivity measurement. The general differential equation of conduction, One dimensional steady state conduction, Linear heat flow through a plane and composite wall, Tube and sphere, Critical thickness of insulation, Effect of variable thermal conductivity, Conduction with heat generation in slab and cylinders, Spheres.	[06]
Unit -3	**Fins:-** Conduction convection system, Extended surfaces rectangular, Triangular, Circumferential and pin fins, General conduction analysis, Fins of uniform and non-uniform cross sectional area. Heat dissipated by a fin. Effectiveness.	[04]
Unit-4	**Transient/Unsteady State Heat Conduction:-** System with negligible internal resistance, Lumped capacity method and its Validity. Unsteady state conduction through finite and semi- infinite slab without surface resistance, convection boundary conditions. Solution through Heisler`s chart.	[06]
Unit-5	**Forced Convection:-** Physical Mechanism of Forced Convection, Dimensional analysis for forced convection, velocity and Thermal Boundary layer, Flow over plates, Flow across cylinders and spheres, Flow in tubes , Reynolds' sanalogy	[05]
Unit-6	**Natural Convection:-** Physical Mechanism of Natural Convection, Dimensional analysis of natural convection; Empirical relationship for natural convection.	[05]
Unit-7	**Boiling and condensation:-** Condensation and boiling heat transfer – film and drop wise condensation – film boiling and pool boiling – boiling curve – empirical relations for heat transfer with change of face .Boiling heat transfer, Pool boiling.	[04]
Unit-8	**Heat Exchangers:-** Different types of heat exchangers; Determination of heat exchanger performance, Heat exchanger transfer units, Analysis restricted to parallel and counter flow heat exchanger (LMTD and NTU method)	[04]
Unit-9	**Thermal Radiation:-** Introduction, absorption and reflection of radiant energy, Emission, Radiosity and irradiation, Black and non black bodies, Kirchhoff's law, intensity of radiation, Radiation exchange between black surface, Geometric Configuration factors. Grey body relation exchange between surface of unit configuration factors, Electrical analogy to simple problems. Non-luminous gas radiation errors in temperature measurement due to radiation.	[04]
	Total	42

Text Book(s):

1. S.P. Sukhatme, Heat Transfer,4th Ed., Tata McGrawHill,2008
2. J.P. Holman, Heat Transfer, 10th Ed., Tata McGrawHill,2011

Reference Book(s):

1. Yunus A. Cengel, Heat Transfer – A Practical Approach,2nd Ed., McGrawHill,2002
2. P.S. Ghoshdastidar, Heat Transfer,2nd Ed., Oxford UniversityPress,2012

STRUCTURAL FIRE PROTECTION

Subject Code	Theory			No of Period in one session : 42			Credits
2048404	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
				CT	:	20	

Rationale:
Structural fire protection refers to fire protection methods incorporated into a building's design and construction. It helps to ensure that the building's structural integrity is maintained and protected for as long as possible should a fire materialize

Outcomes:
After completion of this course student will be able to

1. Understand Engineering approaches to Industrial Fire Protection
2. Construct Fire Resistance building, Warehouse and special storage building.
3. Apply properties of smoke during fire

Contents : Theory		Hrs
Unit -1	**Engineering Approach to industrial fire protection** Fire/explosion scenario identification, Consequence analysis, Alternative protection evaluation; Statistical overview of industrial fires and explosions – Industrial occupancies in large loss fires, Types of fires/ explosions in the largest losses	[08]
Unit -2	**Plant Siting and layout** Fire protection sitting considerations – Safe separation distances, Water supplies, Fire fighting organizations, Codes and attitudes, Environmental effects; Plant layout for fire/explosion protection – General principles and procedures,	[06]
Unit -3	**Fire Resistant Construction** Construction materials – Steel, Steel Insulation, Concrete; Fire resistance calculations; Fire resistance tests – Furnace exposure tests, Empirical correlations, High intensity fire resistance tests; Fire Walls – General criteria for fire walls, Fire wall design	[06]
Unit-4	**Smoke Production & Properties** Particle size of smoke from burning wood and plastics, Smoke Aerosol Properties, Visibility, Smoke isolation and venting; Isolation and suppression within ventilated equipment; Isolation within rooms – Building smoke control – Buoyancy pressure differences, Volumetric expansion pressures,	[06]
Unit-5	**Warehouse Storage** Warehouse fire losses Storage configurations; Effect of storage height, flue space and aisle width; Commodity effects – Generic commodity classification, Laboratory flammability testing, Small array tests, Large array sprinklered fire tests; Sprinkler flow rate requirements – Ceiling spray sprinklers criteria; Fire suppression criteria; Cold storage warehouse fire protection	[08]

Unit-6	**<u>Storage of special commodities and bulk materials:-</u>** **Roll paper-** Commodity description, Loss experience, Roll paper fire tests, Roll paper protection requirements; Nonwoven roll goods – Commodity description, Loss experience, Fire tests, Sprinkler protection requirements for nonwovens; Rubber tire storage; Aerosol Products – Product description,	**[08]**
	Total	**42**

Reference Book(s):

1. Industrial Fire Protection Engineering – Robert G.Zalosh
2. National Fire Protection Association Handbook
3. Hydro Carbon Processing Unit Volume I,II
4. An Introduction to Fire Dynamics – Dougal Drysdale
5. Automatic Sprinkler performance table, Fire Journal, NFPA, 1970Edition
6. Evaporation from plain liquid surface into a turbulent boundary layer – By Brighton P.W.N
7. Factory Mutual loss prevention data sheet, 1-20 protection against fire protection
8. Factory Mutual loss prevention data sheet 2-8, Earthquake, Protection for sprinkler syste

FIRE SUPPRESSION SYSTEM

Subject Code	Theory			No of Period in one session : 42			Credits
2048405	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
				CT	:	20	

Rationale:-

A fire suppression system is any product designed to stop a fire from spreading. It gets the name suppression system as it aims to hold back the fire and the damage it may cause. Preventing the fire from spreading mitigates losses and allows time for emergency personnel to respond.

Course Outcomes:-

After completion of course student will be able to:-

1. Understand various component of Water based Suppression System, Foam based suppression system, Carbon dioxide suppression system, Halon suppression system, Dry and wet Chemical suppression system, Manual Fire Suppression system.
2. Use Portable fire extinguishers.
3. Classify different basic Components of Water based suppression system.
4. Pecos rise different fire suppression systems.

	Contents : Theory	Hrs
Unit -1	**Suppression Agents and Extinguishing Mechanisms** Life Cycle of Fire/Fire Triangle/Fire Tetrahedron. Theories of suppression and extinguishment. Suppression agents/attributes.	[06]
Unit -2	**Water-Based Suppression Systems** Basic components of water-based suppression systems. Types of systems / components / applications. Attributes of system components. Hazard classifications / System design criteria. Spacing / location / placement of discharge devices. Methods for sizing piping / piping configurations. Hydraulic calculations.	[10]
Unit -3	**Foam Suppression Systems** Basic components of foam suppression systems. Types of systems / components / applications Attributes of system components. System design criteria .Spacing / location / placement of discharge devices. Methods for sizing piping / piping configurations. Hydraulic calculations.	[10]
Unit -4	**Carbon Dioxide Suppression Systems** Basic components of carbon dioxide suppression systems. Types of systems / components / applications. Attributes of system components. System design criteria. Spacing / location / placement of discharge devices. Methods for sizing piping / piping configurations. Agent supply requirements. Safety considerations.	[06]
Unit-5	**Dry and Wet Chemical Suppression Systems** Basic components of dry and wet chemical suppression systems. Types of systems / components / applications. Attributes of system components. System design criteria. Spacing / location / placement of discharge devices. Methods for sizing piping / piping configurations.	[04]

Unit-6	**<u>Manual Fire Suppression Systems</u>** Portable Fire Extinguishers - Classifications of portable fire extinguishers. Testing of portable fire extinguishers. Spacing / location / placement of discharge devices. Standpipe and Hose Systems - Basic components of standpipe and hose systems. Types of systems / components / applications. Attributes of system components. System design criteria. Spacing / location / placement of discharge devices. Methods for sizing piping / piping configurations.	[06]
	Total	**42**

Reference Books:

1. Fire Suppression and Detection Systems - Ch. 1-2; Friedman (1991)
2. Automatic Sprinkler Systems Handbook; Automatic Sprinkler and Standpipe Systems; Solomon (1991:1); Fleming (1991:2); Solomon (1991:2); Fleming (1991:1); Cote and Fleming (1991); Hodnett (1991); Fleming (1988)
3. Fire Suppression and Detection Systems - Ch. 3-4; Meldrum (1991); Hickley (1988)
4. Fire Suppression and Detection Systems - Ch. 6; NFPA 12; Wysocki (1991)
5. Fire Suppression and Detection Systems - Ch. 7; NFPA 12A, 12B; Taylor (1991); Grant (1988)
6. Fire Suppression and Detection Systems - Ch. 2; NFPA 10; Demers (1991)
7. Automatic Sprinkler and Standpipe Systems - Ch. 1; NFPA 14; Shapiro (1991)

ELECTRICAL WORKSHOP FIRE PROTECTION LAB

Subject Code 2048406	Practical			No of Period Session : 56		Credit
	Number of Period Per Week			Full Marks	50	2
	L	T	P/S	Internal (PA)	15	
			4	External (ESE)	35	

LIST OF EXPERIMENTS :

Content: Practical	
1.	Study of Introduction of tools, electrical materials, symbols and abbreviations.
2.	Study of stair case wiring.
3.	Study of house wiring i.e., batten, cleat, casing-caping and conduit wirings.
4.	Study of fluorescent tube light.
5.	Study of circuit of a Simple power supply with regulation & filters.
6.	Study of Circuit of a SMPS. 7. To study circuit & working of a U.P.S.
7.	Study of Circuit & working of a Home Inverter.
8.	Study of construction of moving iron, moving coil, electro dynamic & induction type motors.
9.	Perform experiments to design & fabricate single phase transformer.
10.	Study of fuses MCBs and importance of earthing.
11.	Perform experiments for fabricate a simple PCB using screens printing or any other technique.
12.	Drilling & mounting of components on above PCB.

Practical Outcomes :-
After completion of course student will be able to:-

- Identify different tools & materials for fire protection.
- Perform fabrication of simple PCB.
- Use drilling & mounting instruments for PCB.
- Study different types of wiring & Circuits.

PUMPING MACHINERY & FLUID MECHANICS LAB

Subject Code 2048407	Practical			No of Period Session : 28		Credit
	Number of Period Per Week			Full Marks	50	01
	L	T	P/S	Internal (PA)	15	
			2	External (ESE)	35	

	Content: Practical	Hrs
List of Experiments:	1. Study for Introduction to FM lab, properties of fluids.	02
	2. Determination of co-efficient of friction of flow in a pipe.	02
	3. Determination of minor losses in flow through pipes.	04
	4. Determination of force developed by impact of jets on vanes.	04
	5. Determination of co-efficient of discharge through orifice plate meter.	04
	6. Determination of co-efficient of discharge through nozzle by venturimeter.	02
	7. Determination of co-efficient of discharge through v-notch.	02
	8. Study of Centrifugal Pump Characteristics.	02
	9. Study of force balances in a Static System.	02
	10. Study of Different Types of Flow.	02
	11. Determination of the loss of head in the fittings at the various water flow rates.	02

Practical Outcomes :-

After completion of course student will be able to:-

1. Determine Co-efficient of friction of flow in Pipe.
2. Calculate Co-efficient of discharge through nozzle.
3. Understand the process of determination of force developed by impact of sets on vanes.
4. Prepare list of equipment and tools for pumping machinery and fluid mechanics.

Ref. Books. :-

FIRE FIGHTING AND FIELD TRAINING-II

Subject Code 2048408	Practical			No of Period Session : 56		Credit
	Number of Period Per Week			Full Marks	50	2
	L	T	P/S	Internal (PA)	15	
			4	External (ESE)	35	

Practical Outcomes:

After completion of course student will be able to:-

1. Demonstrate different fire extinguishers.
2. Perform standard drills.
3. Hydrants, Clearings and testing processes.

List of Experiments-

	Content: Practical	Hrs.
1.	1. Demonstration of fire extinguishers methods of recharging after discharge, 2. Perform general maintenance procedure & Standard tests.	**10**
2.	1. Standard drills with care and maintenance of liquid foam and foam equipment. 2. Perform one man and two man standard drills with hose and fir rescue.	**10**
3.	1. Study to run with hose, lay and make up lines of hose, adding, replacing or removing lengths of hose when changed. two and three man hose drills	**12**
4.	1. Perform experience for Operation of hydrants, Cleaning and testing etc. 2. Study of Types of Knots and their uses 3. Study of Picking up, Lowering and carrying insensible person, Lines rescue.	**12**
5.	Visit of fire fishing and field Training Centers.	**12**

Important Point The field training based on the following is to be performed Hose Drills

1. General movements to be noted for handling delivery hose, hydrant Drill (3-Men) Hydrant Drill (4-Men).

2. Pump Drills Trailer Pump Drill (Four Men), Trailer Pump Drill (Six Men), Motor Fire Engine (without escape)/Water Tender Drill (Six Men), First Aid Hose reel Drill (Three Men).

3. Ladder Drills: Extension Ladder (Four Men), Hook Ladder Drill, Hook Ladder Drill (One Men), Hook Ladder Drill (Two Men), Hook Ladder Drill (Three Men), Fire escape Ladder Drill (Six Men), getting a Branch to work up on Escape Ladder, getting a Branch to work from an escape Ladder, Turn Table, Ladder Drill (Six Men), Hydraulic Platform. Drill (Six Men). Foam Drill (F.B.-2) Foam Drill with inline inductor (Six Men)

Minor Project

Subject Code 2048409	Term Work			No of Period Session : 42		Credit
	Number of Period Per Week			Full Marks	50	1
	L	T	P/S	Internal (PA)	15	
			3	External (ESE)	35	

A. The projects if done right can help enthusiastic Fire technology and safety engineering students to develop the skills/profile needed for an exciting career in core technologies. Since practical skills are very important to work on core industries, experts tend to analyze candidate's performance based on their project experience during the interviews

B. These projects provide an excellent opportunity to learn and showcase your practical skills to your future interviewers easily. If spent qualitatively you can build a very innovative electrical project and get a great learning experience. By doing so, you will not only develop an innovative project but also develop valuable skills needed for a successful career in core technologies related to electrical engineering. The best way to master a subject is by doing projects. Through a project you not only get a deeper understanding of the subject but also gain hands-on practical experience. If you are looking to do internships in college, the best way to catch the companies' attention is through projects

C. Projects are generally done as a combined team effort. Two or more students work under a guide or a staff to get a certain result. By doing a project, you will

1. Understand your subject better
2. Get practical experience
3. Chance to showcase your skills
4. Learn about team work, communication skills and responsibilities

When companies look for interns, they prefer students who have good understanding of the subject with at least some hands-on experience. The best to achieve both is by doing projects.

There is no fixed time to do a project. You can do it right from your first year in college. If you are looking to do a technical project, then the best time to start would be mid second year. It's not mandatory that you do many projects but make sure that you at least do one project. A lot of students tend to do few small projects from their second year and do a big project in their final year. By showcasing your projects, you can even look for internships while in college

COURSE UNDER MOOCS/ SWAYAM/ OTHER

Subject Code 2048410	Term Work			No of Period Session : 56		Credit
	Number of Period Per Week			Full Marks	50	2
	L	T	P/S	Internal (PA)	15	
			4	External (ESE)	35	