



**BANGLADESH TECHNICAL EDUCATION BOARD**

**Agargaon, Sher-E-Bangla Nagar**

**Dhaka-1207.**

**04-YEAR DIPLOMA IN ENGINEERING CURRICULUM  
COURSE STRUCTURE & SYLLABUS  
(PROBIDHAN-2022)**

**MECHANICAL TECHNOLOGY**

**TECHNOLOGY CODE: 70**

**4<sup>TH</sup> SEMESTER**

**(Effective from 2022-2023 Academic Sessions)**

## DIPLOMA IN ENGINEERING CURRICULUM COURSE STRUCTURE

(PROBIDHAN-2022)

**TECHNOLOGY NAME: MECHANICAL TECHNOLOGY (70)**

(4<sup>TH</sup> SEMESTER)

Sl. No.	Subject Code & Name		Period Per Week		Credit	Marks Distribution						Grand Total
						Theory Assessment			Practical Assessment			
	Code	Name	Theory	Practical		Continuous	Final	Total	Continuous	Final	Total	
1	25841	Accounting	2	-	2	40	60	100	-	-	-	100
2	26811	Basic Electronics	2	3	3	40	60	100	25	25	50	150
3	27041	Engineering Mechanics	2	3	3	40	60	100	25	25	50	150
4	27042	Machine Shop Practice III	1	6	3	20	30	50	50	50	100	150
5	27043	Metallurgy	2	3	3	40	60	100	25	25	50	150
6	27131	Engineering Thermodynamics	3	3	4	60	90	150	25	25	50	200
7	29041	Environmental Studies	2	3	3	40	60	100	25	25	50	150
<b>Total</b>			<b>14</b>	<b>21</b>	<b>21</b>	<b>280</b>	<b>420</b>	<b>700</b>	<b>175</b>	<b>175</b>	<b>350</b>	<b>1050</b>
<b>Total Period</b>			<b>35</b>									
<b>Theory: Practical (%)</b>			<b>40.0%</b>	<b>60.0%</b>								

Subject code	Subject Name	Period per week		Credit
25841	Accounting	T	P	C
		2	0	2

<b>Rationale</b>	All diploma graduate will work in any institution or organization or will be an employer this subject knowledgeable skill and attitude will health the studies to make appropriate decision for their professional life. This subject will cover the topics like information technology, Evaluation of an organization, journal entry system, cash book analysis and Income Tax.
<b>Learning Outcome (Theoretical)</b>	<p>After undergoing the subject, student will be able to:</p> <ul style="list-style-type: none"> <li>▪ Describe accounting concept</li> <li>▪ Describe transaction analysis</li> <li>▪ Describe accounting entry system.</li> <li>▪ Explain the accounts of debit and credit</li> <li>▪ Interpret the journal entry system.</li> <li>▪ Evaluate the balance of ledger.</li> <li>▪ Describe the cash book analysis.</li> <li>▪ Evaluate of trial balance</li> <li>▪ Explain the financial statement</li> <li>▪ Describe income tax assesment.</li> </ul>

## Detailed Syllabus (Theory)

Unit	Topics with contents	Class (1 Period)	Final Marks
1.	<b>CONCEPT OF ACCOUNTING</b> 1.1 Define accounting. 1.2 State the objectives of accounting. 1.3 State the advantages of accounting. 1.4 State the necessity and scope of accounting.	2	3
2.	<b>TRANSACTION ANALYSIS</b> 2.1 Define transaction. 2.2 Define business transaction. 2.3 Describe the Characteristics of Transaction. 2.4 Discuss the different types of Transaction.	2	3
3.	<b>ENTRY SYSTEM OF ACCOUNTING</b> 3.1 Define single and double entry system. 3.2 Discuss the principles of double entry system. 3.3 Justify whether double entry system is an improvement over the single-entry system. 3.4 Distinguish between single entry and double entry system of accounting	1	3
4.	<b>CONCEPT OF ACCOUNTS</b> 4.1 Define accounts. 4.2 State the objectives of accounts. 4.3 Illustrate different type of accounts. 4.4 State the golden rules of accounting. 4.5 State the rules for debit and credit in each class of accounts. 4.6 Define accounting cycle.	2	3
5.	<b>JOURNAL ENTRY SYSTEM</b> 5.1 Define journal. 5.2 State the objective of journal. 5.3 Mention the various names of journal. 5.4 Prepare the form of journal entry system. 5.5 Solve the problem related journal entry system.	4	10
6.	<b>LEDGER</b> 6.1 Define ledger 6.2 Interpret the form of ledger 6.3 Distinguish between journal and ledger 6.4 Explain "ledger is called the king of all books of accounts" 6.5 Prepare ledger from given transaction	2	3
7.	<b>CASH BOOK ANALYSIS</b> 7.1 Define cash book. 7.2 Classify cash book. 7.3 Explain cash book as both journal and ledger. 7.4 Explain the different types of discount. 7.5 Prepare different types of cash books from given transactions showing balances.	4	10
8.	<b>TRIAL BALANCE ANALYSIS</b> 8.1 Define trial balance. 8.2 State the objective of a trial balance. 8.3 Mention the reasons for non-agreement of trial balance. 8.4 Prepare trial balance from given balance.	3	3
9.	<b>FINAL ACCOUNTS</b>	10	20

	9.1 State the components of final accounts 9.2 Distinguish between trial balance and balance sheet 9.4 List the items to be posted in the trading account profit and loss account and the balance sheet 9.5 Prepare trading account profit and loss account and balance sheet from the given trial balance and other information		
<b>10.</b>	<b>INCOME TAX</b> 10.1 Define income tax. 10.2 State the objective of income tax. 10.3 Classify of assesses. 10.4 State the Taxable income of assesses. 10.5 Describe the Tax rebate. 10.6 Describe ther Income tax year, assessment year and National Board of Revenue (NBR).	<b>2</b>	<b>2</b>
	<b>Total</b>	<b>32</b>	<b>60</b>

### REFERENCE BOOKS

<b>SL</b>	<b>Book Name</b>	<b>Writer Name</b>
1.	Book-Keeping & Accounting	Prof. Gazi Abdus Salam
2.	Principles of Accounting	Hafiz uddin
3.	Cost Accounting	Prof. Asimuddin Mondol
4.	হিসাবরক্ষন ও হিসাববিজ্ঞান	পরেশ মন্ডল
5.	উচ্চ মাধ্যমিক হিসাববিজ্ঞান	হক ও হোসাইন
6.	আয়কর	ওয়ালীউল্লাহ

Subject Code	Subject Name	Period per Week		Credit
26811	BASIC ELECTRONICS	T	P	C
		2	3	3

<b>Rationale</b>	<p>Electronic devices have become an important part of our day-by-day life. Now a days it is difficult for us to live without electronic device. We live in a generation that uses electronics and smart technologies. Where robots and artificial intelligence is capable of doing human works in all technological equipment with more ease and efficiency. Operation of all machines, devices and equipment are controlled by electronic device and circuits. This subject covers only such topics which will enable the diploma engineers to identify and maintenance the electronics parts and able to proper fault finding.</p>
<b>Learning Outcome (Theoretical)</b>	<p><b>After undergoing the subject, students will be able to:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Describe soldering</li> <li><input type="checkbox"/> Determine the value of Capacitor &amp; Resistor using numeric and color code.</li> <li><input type="checkbox"/> Describe Semiconductor and Semiconductor Diode.</li> <li><input type="checkbox"/> Describe Rectifier circuits</li> <li><input type="checkbox"/> Explain Construction and characteristics of PNP and NPN Transistor.</li> <li><input type="checkbox"/> Explain the construction and operation of Single and Multi-stage amplifier</li> </ul>
<b>Learning Outcome (Practical)</b>	<p><b>After undergoing the subject, students will be able to:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Perform soldering.</li> <li><input type="checkbox"/> Calculate values of different resistors and capacitors with the help of color code.</li> <li><input type="checkbox"/> Check the semiconductor diode and Determine characteristics of Diode</li> <li><input type="checkbox"/> Verify the wave-shape of half-wave and full wave rectifier circuit</li> <li><input type="checkbox"/> Test special diodes.</li> <li><input type="checkbox"/> Verify the bipolar junction transistor characteristics.</li> <li><input type="checkbox"/> Determining Q-Point and gain of transistor amplifier.</li> <li><input type="checkbox"/> Determining frequency response of single stage R-C coupled transistor amplifier.</li> </ul>

**Detailed Syllabus (Theory)**

Unit	Topics with Contents	Class (3 Period)	Final Marks
1.	<b>SOLDERING AND COLOR CODE</b> 1.1 Define soldering. 1.2 List the materials of soldering. 1.3 Describe the steps of soldering. 1.4 Mention the properties of a good soldering joint. 1.5 Describe the active and passive components used in electronic circuits. 1.6 Mention the function of resistor, capacitor and inductor in electronic circuits. 1.7 Describe the procedure of determining the value of Capacitor, & Resistor using numeric and color code.	3	4
2	<b>SEMICONDUCTOR</b> 2.1 Define conductor, semiconductor and insulator. 2.2 Describe semiconductor with atomic structure. 2.3 Describe the effect of temperature on conductivity of Semiconductor. 2.4 Classify Semiconductor. 2.5 List the commonly used semiconductor 2.6 Describe the formation of P-type and N-type semiconductor. 2.7 Describe the charges on N-type and P-type Semiconductor 2.8 Explain the majority & minority charge carriers of P-type & N-Type Semiconductor.	3	4
3	<b>SEMICONDUCTOR DIODE</b> 3.1 Define PN junction diode 3.2 Describe the formation of PN junction. 3.3 Explain forward and reverse bias in PN junction. 3.4 Explain the forward and reverse Voltage-Current (VI) characteristics curve of PN junction diode. 3.5 Define load line, static resistance, (iii) dynamic resistance, 3.6 Define forward breakdown voltage, (v) Peak inverse voltage (PIV) and (vi) Reverse break down voltage. 3.7 Describe the specification of PN Junction diode.	3	4
4	<b>SPECIAL DIODES</b> 4.1 Define Zener Diode. 4.2 Describe the operation of Zener diode. 4.3 Explain Volt-Ampere (VI) characteristics of Zener diode. 4.4 Describe the application of Zener diode in, voltage stabilization, meter protection and peak clipper circuits. 4.5 Describe the construction, operation and application of Tunnel diode, Varactor diode, Schottky diode, Step-Recovery diode, PIN diode, LED, LCD, photo diode and Solar cell.	3	4
5	<b>DC POWER SUPPLY</b> 5.1 Define dc power supply	3	8

	<p>5.2 Describe importance of dc power supply.</p> <p>5.3 Compare regulated and unregulated power supply.</p> <p>5.4 Describe the operation of a typical regulated dc power supply with block diagram.</p> <p>5.5 Define rectifier and rectification.</p> <p>5.6 Explain the operation of half wave, full wave and bridge rectifier circuit.</p> <p>5.7 Determine the ripple factor, efficiency and TUF of half wave, full wave and bridge rectifier.</p> <p>5.8 Explain the operation of capacitor, inductor-capacitor and pi (<math>\pi</math>) filter circuit.</p> <p>5.9 Solve problem related to ripple factor, efficiency and TUF.</p>		
6	<p><b>BIPOLAR JUNCTION TRANSISTOR (BJT)</b></p> <p>6.1 Define Transistor.</p> <p>6.2 Describe the construction of PNP and NPN Transistor.</p> <p>6.3 Explain the mechanism of current flow of PNP and NPN Transistor.</p> <p>6.4 State the biasing rules of BJT.</p> <p>6.5 Establish the relation among Base, Emitter and Collector current (<math>I_E = I_C + I_B</math>).</p>	2	4
7	<p><b>Transistor Characteristics</b></p> <p>7.1 Describe three basic transistor configuration (CB, CC, CE) circuits.</p> <p>7.2 Explain the characteristics curve of CB, CC and CE transistor configurations.</p> <p>7.3 Describe current amplification factor <math>\alpha</math>, <math>\beta</math> and <math>\gamma</math>.</p> <p><b>7.4</b> Establish the relation among <math>\alpha</math>, <math>\beta</math> and <math>\gamma</math>.</p> <p><b>7.5</b> Solve problem related to <math>I_E</math>, <math>I_C</math>, <math>I_B</math>, <math>\alpha</math>, <math>\beta</math> and <math>\gamma</math></p>	3	4
8	<p><b>TRANSISTOR BIASING AND STABILIZATION</b></p> <p>8.1 Define load line, Operating point, stability and stabilization.</p> <p>8.2 State the biasing rule of transistor.</p> <p>8.3 Describe faithful amplification.</p> <p>8.4 Describe the methods of drawing DC load line.</p> <p>8.5 Explain the leakage current in CB &amp; CE circuits.</p> <p>8.6 List the factors affecting stability of Q-points.</p> <p>8.7 Describe various methods of transistor biasing.</p> <p>8.8 Determine the stability factor of various transistor biasing circuits.</p> <p>8.9 Solve problem related to components values, Q-Points and stability factor.</p>	4	8
9	<p><b>SINGLE STAGE TRANSISTOR AMPLIFIER</b></p> <p>9.1 Define amplifier and single stage amplifier.</p> <p>9.2 Mention the types of amplifier.</p> <p>9.3 Explain operation of transistor as amplifier with graphical demonstration.</p> <p>9.4 Describe the operation of voltage divider biased CE amplifier circuit.</p> <p>9.5 Explain the phase reversal of CE amplifier.</p> <p>9.6 Draw DC and AC equivalent circuit of voltage divider biased CE</p>	4	10



	<p>amplifier circuit.</p> <p>9.7 Determine the AC equivalent load resistance of the CE amplifier circuit.</p> <p>9.8 Determine voltage and power gain of the CE amplifier circuit.</p> <p>9.9 Solve problem related to voltage and power gain where <math>\beta</math> and input resistance of the transistor are given.</p>		
10	<p><b>MULTISTAGE TRANSISTOR AMPLIFIER</b></p> <p>10.1 Define Multi stage amplifier.</p> <p>10.2 Describe role of capacitor in single stage amplifier.</p> <p>10.3 Describe gain, decibel gain frequency response, half power point, 3db point and bandwidth.</p> <p>10.4 Mention the advantages of dB gain.</p> <p>10.5 Describe the operation of RC coupled, Transformer coupled and direct coupled multistage amplifier.</p> <p>10.6 Explain the frequency response of RC coupled, Transformer coupled and direct coupled multistage amplifier.</p> <p>10.7 Mention the advantages and disadvantages of RC coupled, Transformer coupled and direct coupled multistage amplifier.</p> <p>10.8 Solve problem related to voltage and power gain where <math>\beta</math> and input resistance of the transistor are given.</p>	4	10
	<b>Total</b>	<b>32</b>	<b>60</b>

### Detailed Syllabus (Practical)

Unit	Experiment name with procedure	Class (3 Period)	Marks (Continuous)
1	<p><b>Solder &amp; de-solder of electronic components and wires to the other components and circuit boards.</b></p> <p>1.1. Select electronic components, wires and PCB.</p> <p>1.2. Select the rating of the soldering iron suitable for the work piece.</p> <p>1.3. Clean and tin both iron &amp; work piece.</p> <p>1.4. Feed new soldering materials to the tinned and heated joint in order to produce a correct soldering.</p> <p>1.5. Check the quality of soldering.</p> <p>1.6. Clean and tin iron and de-solder the joint and components.</p> <p>1.7. Use solder suckers and solder braid for de-soldering.</p> <p>1.8. Maintain the record of performed job.</p>	1	3
2	<p><b>Determine the values of different resistors, capacitors and inductor.</b></p> <p>2.1 Select resistors, capacitors and inductors of different values.</p> <p>2.2 Identify the colors or numeric code</p> <p>2.3 Determine the value of resistors, capacitor <b>and inductor</b> with tolerance. .</p> <p>2.4 Maintain the record of performed job.</p>	1	2

3	<p><b>Sketch forward and reverse characteristics curves of a semiconductor diode.</b></p> <p>3.1 Select meter, power supply, components and materials.</p> <p>3.2 Complete circuit according to circuit diagram for forward bias.</p> <p>3.3 Check all connections.</p> <p>3.4 Apply different forward voltage and measure corresponding forward current.</p> <p>3.5 Record results in tabular form.</p> <p>3.6 Connect circuit according to circuit diagram of reverse bias.</p> <p>3.7 Apply different reverse voltage and measure corresponding forward current.</p> <p>3.8 Record results in tabular form.</p> <p>3.9 Sketch the VI curves from collected data.</p> <p>3.10 Maintain the record of performed job.</p>	1	2
4	<p><b>Sketch waves of half-wave and full-Wave rectifier circuit</b></p> <p>4.1 Select meter, component, oscilloscope and materials.</p> <p>4.2 Complete circuit of a half wave rectifier according to the circuit diagram.</p> <p>4.3 Check the circuit before operation.</p> <p>4.4 Measure the input and output voltage and observe wave shapes in the oscilloscope.</p> <p>4.5 Sketch the input and output voltage wave shapes.</p> <p>4.6 Maintain the record of performed job.</p>	1	3
5	<p><b>Testing special diodes.</b></p> <p>5.1 Select different types of special diodes.</p> <p>5.2 Set the AVO meter in the ohm scale.</p> <p>5.3 Measure resistances for each of two terminals.</p> <p>5.4 Determine the condition (good and bad).</p> <p>5.5 Determine the different terminals.</p> <p>5.6 Maintain the record of performed job.</p>	2	2
6	<p><b>Identifying the type and terminals of bipolar junction transistor.</b></p> <p>6.1 Select PNP and NPN bipolar junction transistors.</p> <p>6.2 Take AVO and manufacturer's literature of transistor.</p> <p>6.3 Identify transistor terminals.</p> <p>6.4 Measure base-emitter and base-collector resistance.</p> <p>6.5 Determine the specifications with the help of manufacturer's literatures.</p> <p>6.6 Identify PNP, NPN transistors. Base, Collector and Emitter.</p> <p>6.7 Maintain the record of performed job.</p>	2	3
7	<p><b>Determining input and output characteristics of a transistor in common emitter connection.</b></p> <p>7.1. Select DC power supply units, AVO meters, circuit board, components, and required materials.</p> <p>7.2. Construct the circuit.</p> <p>7.3. Adjust the voltage to appropriate point.</p>	2	2

	7.4. Record input and output voltage and current. 7.5. Plot the curve with recorded data. 7.6. Determine the value of $\beta$ . 7.7. Maintain the record of performed job.		
8	<b>Determine the Q- point of R-C coupled CE transistor amplifier.</b> 8.1. Draw the circuit diagram for the experiment. 8.2. Collect tools, equipment and materials. 8.3. Make all the connections according to the circuit diagram. 8.4. Check the connections. 8.5. Energize the circuit and record the Collector emitter voltage and collector current. 8.6. Draw the load line and locate the Q-Point on the load line. 8.7. Maintain the record of performed job.	2	3
9	<b>Determine the voltage gain of CE transistor amplifier.</b> 9.1. Draw the circuit diagram of CE transistor amplifier. 9.2. Collect required tools, equipment and materials. 9.3. Make all the connections according to the circuit diagram. 9.4. Check the connections and Q-Point. 9.5. Energize the circuit and record the input and output voltage. 9.6. Calculate the voltage gain. 9.7. Maintain the record of performed job.	2	2
10	<b>Demonstrate the frequency response of single stage R-C coupled CE transistor amplifier.</b> 10.1. Draw the circuit diagram for the experiment. 10.2. Collect required tools, equipment and materials. 10.3. Make all the connections according to the circuit diagram. 10.4. Check the connections. 10.5. Energize the circuit and record the data. 10.6. Draw the frequency response curve from the data. 10.7. Maintain the record of performed job.	2	3
	<b>Total</b>	<b>16</b>	<b>25</b>

#### Necessary Resources (Tools, Equipments and Machinery):

Sl. No.	Item Name	Quantity
1	Soldering Iron with Stand, De-soldering gun, Third Hand, Hot air gun, Iron Sponge, AVO Meter, Flat screw driver, Philips screw driver, Cutting pliers, Nose pliers, Automatic multifunction wire stripper. Tester, Knife, Power extension board.	30 Nos
2	DC power Supply, Function generator, Oscilloscope, Analog Electronics Trainer, Power project board/ bread board, Center tap Transformer (220/12V, 2A, 5A)	10 nos
3	Diode, Resistor, Potentiometer, Inductor, Capacitor, Transistor, LED, Zener Diode, Photo Diode. Tunnel diode, Varactor diode, Schottky diode, Step-Recovery diode, PIN diode, LCD and Solar cell.	50 nos
4	Resin, soldering lead, Soldering tip, Fixable wire, Wire Brush	as required

**Recommended Books:**

Sl No.	Book Name	Writer Name	Publisher Name & Edition
1	Principles Of Electronics	V. K. Mehta	S.Chand
2	Basic Electronics (Solid State)	B. L. Theraja	S. Chand

**Website References:**

Sl. No.	Web Link	Remarks
1	<a href="https://www.youtube.com/channel/">https://www.youtube.com/channel/</a>	
2	<a href="https://youtu.be/qsWkA-5grogo">https://youtu.be/qsWkA-5grogo</a>	
3	<a href="https://youtu.be/eXyGIPrD5Qk">https://youtu.be/eXyGIPrD5Qk</a>	
4	<a href="https://you.be/f-WiulYIrow">https://you.be/f-WiulYIrow</a>	

Subject Code	Subject Name	Period Per Week		Credit
		T	P	
27041	Engineering Mechanics	2	3	C
				3

<b>Rationale</b>	<p>Engineering mechanics is the branch of Applied Mechanics. Applied mechanics is the part of science concerned with the motion of any substance, examining bodies' response to external forces. In Mechanical Engineering it can be applied in mechatronics and robotics, design and drafting, nanotechnology, machine elements, structure analysis, and aerospace engineering.</p> <p>The Student with a Diploma in Mechanical Engineering Level must be acquired basic knowledge about calculation, applications, and mandatory analysis of Engineering Mechanics. Also required basic knowledge of newly introduced Mechanical technology and other related analysis &amp; calculation. For self-development must be updated with the latest technology.</p> <p>After successfully completing this course, students will be able to identify the Fundamental of mechanics and unit conversion, Composition and resolution of forces, Moment of forces, Couples and their applications, Equilibrium of forces, Center of gravity, Friction, Support reactions force of beam and truss, the moment of inertia, gear trains, and its application.</p>
<b>Learning Outcome (Theoretical)</b>	<p>At the end of the course, the students will be able to:</p> <ul style="list-style-type: none"> <li>▪ State the fundamental of units and conversions of units</li> <li>▪ State the force, effect of the force, composition, and resolution of forces and compute the resultant force</li> <li>▪ State Moment of force &amp; couple</li> <li>▪ State the parallel forces</li> <li>▪ State the centroid and enable computing the center of gravity &amp; the moment of inertia</li> <li>▪ Illustrate laws of friction and the coefficient of friction &amp; the ability to compute frictional forces of reactions of surfaces</li> <li>▪ Derive support reactions and describe types of loading on beams and trusses.</li> <li>▪ State gear trains</li> </ul>
<b>Learning Outcome (Practical)</b>	<p>At the end of the course, the students will be able to:</p> <ul style="list-style-type: none"> <li>▪ Determine the resultant force by using the force board</li> <li>▪ Determine the compression load using a Jib crane</li> <li>▪ Determine the equilibrium force by using the force table</li> <li>▪ Determine the center of a triangular &amp; rectangular lamina</li> <li>▪ Determine the center of gravity of a solid body</li> <li>▪ Determine the coefficient of friction</li> <li>▪ Determine the action of load on the member of a simple frame or trusses</li> <li>▪ Determine the balancing of the moment</li> <li>▪ Determine the velocity ratios among the driver and driven gears</li> </ul>

## Detailed Syllabus (Theory)

Unit	Topics with contents	Class (1 Period)	Final Marks
<b>1</b>	<b>FUNDAMENTAL OF MECHANICS</b> 1.1 Define mechanics 1.2 Mention the Sub-Divisions of Engineering Mechanics 1.3 State Importance of Units in the engineering field 1.4 Discuss the conversion of units 1.5 Illustrate algebra, trigonometry & calculus used in mechanics	2	2
<b>2</b>	<b>COMPOSITION AND RESOLUTION OF FORCES</b> 2.1. State the effect and characteristics of a force 2.2. Describe the different systems of forces 2.3. Describe the resultant force and composition of forces 2.4. State resultant force graphically and analytically 2.5. State the laws of forces 2.6. Define the resolution of a force 2.7. Deduce the formula to find the rectangular components 2.8. Describe the magnitude and position of the resultant force graphically and analytically 2.9. Solve the problems related to the resultant force	4	8
<b>3</b>	<b>MOMENT OF FORCES AND COUPLES</b> 3.1 Define the moment of force 3.2 Mention the units of moment 3.3 Mention the clockwise and anticlockwise moment 3.4 State Varignon's principle of moments 3.5 Define lever and Couple 3.6 State Classification of parallel forces 3.7 Classify Lever and couple 3.8 Solve the problems related to the moment of forces and couple	3	6
<b>4</b>	<b>EQUILIBRIUM OF FORCES</b> 4.1. State the principles of equilibrium forces 4.2. State Lami's theorem 4.3. Derive Lami's theorem 4.4. Describe different methods of the equilibrium of coplanar forces and non-coplanar forces 4.5. Explain the conditions of equilibrium 4.6. Mention the types of equilibrium of forces 4.7. Solve the problems related to the equilibrium of forces	3	6
<b>5</b>	<b>CENTER OF GRAVITY</b> 5.1 Define center of gravity and centroid 5.2 Distinguish between the center of gravity and centroid 5.3 Explain the methods to find out the centroid of the simple geometrical figure 5.4 Illustrate the axis of reference and axis of symmetry	3	6

	<p>5.5 Find out the centroid of a rectangle, triangle and semicircle by using geometrically and integration method</p> <p>5.6 Find out the centroid of the plain geometrical figure by the principle of first moments</p> <p>5.7 Calculate the centroid of the different geometric figure</p> <p>5.8 Calculate the center of gravity of solid bodies</p> <p>5.9 Solve the problems related to the center of gravity</p>		
6	<p><b>MOMENT OF INERTIA</b></p> <p>6.1 Describe the moment of inertia and the units of the moment of inertia</p> <p>6.2 Describe the methods to find out the moment of inertia</p> <p>6.3 Find the moment of inertia of simple areas by the method of integration</p> <p>6.4 State and proof of the theorem of the perpendicular axis as applied to the moment of inertia</p> <p>6.5 State the parallel axis theorem in the determination of the moment of inertia of areas</p> <p>6.6 Explain the radius of gyration and section modulus</p> <p>6.7 Define mass moment of inertia</p> <p>6.8 Mention the Application of mass moment of inertia</p> <p>6.9 Calculate and Solve the problems related to the moment of inertia and section modulus of composite sections and simple solid bodies</p>	4	8
7	<p><b>FRICTION</b></p> <p>7.1 Define friction</p> <p>7.2 Describe the advantages and disadvantages of friction</p> <p>7.3 Mention the types of friction</p> <p>7.4 State the laws of static and dynamic friction</p> <p>7.5 Explain the angle of friction</p> <p>7.6 Explain the classification of the co-efficient of friction</p> <p>7.7 Explain free body diagrams of a body lying on horizontal, inclined and vertical surfaces, ladder and wedge</p> <p>7.8 Calculate the frictional force of a body lying on horizontal and inclined surfaces</p> <p>7.9 Describe the methods to solve the problems of ladder and wedge</p> <p>7.10 Solve the problems related to friction</p>	4	6
8	<p><b>SUPPORT REACTION FORCES ON BEAM</b></p> <p>8.1 Define beam</p> <p>8.2 Define support and support reactions</p> <p>8.3 Classify supports</p> <p>8.4 Describe different types of beams</p> <p>8.5 Explain different types of loads on the beam</p> <p>8.6 Calculate the support reactions of simple, overhanging and cantilever beam with different loading conditions</p> <p>8.7 Solve the problems related to support reaction forces on the beam</p>	3	6
9	<p><b>SUPPORT REACTION FORCES ON TRUSS</b></p> <p>9.1 Define truss</p>	3	6

	9.2 Classify truss 9.3 Describe perfect and imperfect truss 9.4 State the method to find out the support reaction and forces on the member of the truss 9.5 Mention the nature of force on the members of the truss 9.6 Solve the problem-related with truss		
<b>10</b>	<b>GEAR TRAINS</b> 10.1 Define gear 10.2 Mention the types of gear 10.3 Define gear train 10.4 Classify gear train 10.5 State simple, compound, and epicyclical gear train 10.6 Express the velocity ratio of the simple, compound and epicyclical gear train 10.7 Solve the problems related to gear trains	3	6
	<b>Total</b>	<b>32</b>	<b>60</b>

### Detailed Syllabus (Practical)

Sl.	Experiment name with the procedure	Class (3 Period)	Continuous Marks
<b>1</b>	<b>DETERMINE THE RESULTANT FORCE BY USING THE FORCE BOARD</b> 1.1 Set up the force board 1.2 Set up the accessories on the force board 1.3 Find the resultant force 1.4 Calculate the magnitude of the resultant force 1.5 Perform the Comparison of calculated values with experimental values 1.6 Maintain the record of the performed task	1	2
<b>2</b>	<b>DETERMINE THE FORCES IN THE MEMBERS OF A JIB CRANE</b> 2.1 Set up the Jib crane 2.2 Set up the accessories on the Jib crane 2.3 Find the compression loads on the Jib 2.4 Calculate the compression analytically 2.5 Compare the experimental values with analytical values 2.6 Maintain the record of the performed task	1	3
<b>3</b>	<b>DETERMINE THE EQUILIBRIUM FORCE BY USING THE FORCE TABLE</b> 3.1 Set up the force table 3.2 Set up the accessories on the force table 3.3 Find the magnitude and direction of a force establishing equilibrium 3.4 Calculate the magnitude and direction of the equilibrium force 3.5 Compare the calculated values with experimental values 3.6 Maintain the record of the performed task	2	3
<b>4</b>	<b>DETERMINE THE CENTER OF A TRIANGULAR LAMINA</b> 4.1 Select a triangular lamina and a plumb bob 4.2 Set up the plumb bob 4.3 Find the center point of the triangular lamina	1	3



	4.4 Maintain the record of the performed task		
5	<b>DETERMINE THE CENTER OF A RECTANGULAR LAMINA</b> 5.1. Select a rectangular lamina and a plumb bob 5.2. Set up the plumb bob 5.3. Find the center point of the rectangular lamina 5.4. Maintain the record of the performed task	1	2
6	<b>DETERMINE THE CENTER OF GRAVITY OF A SOLID BODY</b> 6.1. Select a solid rod, step rod, and body with cut-out holes of solid bodies 6.2. Select a fulcrum 6.3. Set up the fulcrum 6.4. Find the center point 6.5. Compare the analytical values with experimental values 6.6. Maintain the record of the performed task	2	3
7	<b>DETERMINE THE COEFFICIENT OF FRICTION</b> 7.1 Set up the friction apparatus 7.2 Select the materials of which the coefficient of friction is to be determined 7.3 Place the materials over each other 7.4 Raise one end of the body until the other body slides down 7.5 Find the angle of friction 7.6 Find the coefficient of friction 7.7 Maintain the record of the performed task	2	3
8	<b>DETERMINE THE ACTION OF LOAD ON THE MEMBER OF A SIMPLE FRAME OR TRUSS</b> 8.1 Select two members of which one end roller and the other end pinpoint 8.2 Select a tension spring 8.3 Make a unit as a simple frame or truss 8.4 Apply the load 8.5 Read the tension load on the spring 8.6 Maintain the record of the performed task	2	2
9	<b>DETERMINE THE BALANCING OF THE MOMENT</b> 9.1 Set up the bell crank lever 9.2 Set up the accessories on the bell crank lever 9.3 Compare the clockwise and anticlockwise moment 9.4 Read tension on the spring balance 9.5 Compare the experimental values with analytical values 9.6 Maintain the record of the performed task	2	2
10	<b>DETERMINE THE VELOCITY RATIOS AMONG THE DRIVER AND DRIVEN GEARS</b> 10.1 Set a simple train of gears 10.2. Compare the velocity ratios of the same 10.3. Set a compound train of gears 10.4. Compare the velocity ratios of the same	2	2

	10.5. Maintain the record of performed task		
		<b>Total</b>	<b>16</b>
			<b>25</b>

**Necessary Resources (Tools, equipment and Machinery):**

Sl.	Item Name	Quantity
01	Forces Kit including Work Panel	Each item 5 Set
02	Friction and Inclined Plane Kit including Work Panel	Each item 5 Set
03	Gear Trains Kit including Work Panel	Each item 5 Set
04	Equilibrium of Forces including Statics Works Panel	Each item 5 Set
05	Pin Jointed Frameworks	Each item 5 Set
06	Laptop, Multimedia & Hi-speed internet connection.	Each item 2 Nos

**Recommended Books:**

Sl	Book Name	Writer Name	Publisher Name & Edition
01	Applied Mechanics	R. S. Khurmi, J.K Gupta	14th Edition& S. Chand & Company Ltd.
02	Engineering Mechanics	Russell Hibbeler	14 <sup>th</sup> Edition&
03	A Textbook of Applied Mechanics	R. K. Rajput	4th Edition, Kindle Edition

Sl	Web Link for Books	Remarks
01	Applied Mechanics Dynamics	<a href="https://www.pdfdrive.com/applied-mechanics-dynamics-d5674220.html">https://www.pdfdrive.com/applied-mechanics-dynamics-d5674220.html</a>
02	A Textbook of Engineering Mechanics	<a href="https://books.google.com.bd/url?id=AKEbEAAAQBAJ&amp;pg=PP4&amp;q=http://www.schandpublishing.com&amp;linkid=1&amp;usg=AOvVaw0Untnj0xMDuTPARpClepDF&amp;source=gbs_pub_info_r">https://books.google.com.bd/url?id=AKEbEAAAQBAJ&amp;pg=PP4&amp;q=http://www.schandpublishing.com&amp;linkid=1&amp;usg=AOvVaw0Untnj0xMDuTPARpClepDF&amp;source=gbs_pub_info_r</a>
03	Applied Mechanics	<a href="https://www.researchgate.net/publication/340999448_Applied_Mechanics">https://www.researchgate.net/publication/340999448_Applied_Mechanics</a>
04	Applied Mechanics	<a href="https://www.youtube.com/watch?v=4-oZM1TYjyQ">https://www.youtube.com/watch?v=4-oZM1TYjyQ</a>

**Website References:**

Sl	Web Link	Experiment name with the procedure	Remarks
01	<a href="https://www.youtube.com/watch?v=PYv8cGQrZN8">https://www.youtube.com/watch?v=PYv8cGQrZN8</a>	Determination of Force and Centre of Gravity	
02	<a href="https://www.youtube.com/watch?v=n1JTt_7BS80">https://www.youtube.com/watch?v=n1JTt_7BS80</a>	Determination of Friction	
03	<a href="https://www.youtube.com/watch?v=mUUCH7ocsvs">https://www.youtube.com/watch?v=mUUCH7ocsvs</a>	Determination of Gear Ratio, Efficiency	
04	<a href="https://www.youtube.com/watch?v=jmL-mcjXxHQ">https://www.youtube.com/watch?v=jmL-mcjXxHQ</a>	Determination of Equilibrium of Forces	
05	<a href="https://www.youtube.com/watch?v=maIARO_euBo">https://www.youtube.com/watch?v=maIARO_euBo</a>	Determination of Forces and deflections in different frameworks	
	<a href="https://youtu.be/U5MMgLFShvA">https://youtu.be/U5MMgLFShvA</a>	Determine The Balancing of The Moment	

Subject Code	Subject Name	Period Per Week		Credit
27042	Machine shop practice - 3	T	P	C
		1	6	3

<b>Rationale</b>	Diploma in Engineering Level students are required to acquire the knowledge and skill on concept of precision grinding, tool and cutter grinding programming of CNC lathe & CNC milling and super finishing machine. After completion of this course student will be able to perform surface finishing operation, tool and cutter grinding machine operation, Mandrel, gear blank & gear (helical & bevel) cutting by using conventional machine. On the other hand, student able to facing, plain turning, step turning, taper turning, grooving, boring and thread cutting by using CNC lathe machine and straight slotting, circular slotting, square slotting, drilling by using milling machine. As such the knowledge of Machine shop practice – 3 the pre-requisite for these fields for effective discharge of their duties. These necessities the introduction of Mechanical Engineering subject in the curriculum of Diploma in Engineering level. The subject covers only such topics which will enable the diploma engineers to prepare of Engineering parts, Gear and super finishing parts. The emphasis will be more on practical rather than theory.
<b>Learning Outcome (Theoretical)</b>	At the end of the course the students will be able to: <ul style="list-style-type: none"> <li>▪ State precision Grinding.</li> <li>▪ Describe Tool &amp; cutter Grinder.</li> <li>▪ Explain CNC lathe machine.</li> <li>▪ Explain CNC milling machine.</li> <li>▪ Discuss Super finishing machine.</li> <li>▪ Describe honing and lapping operation.</li> </ul>
<b>Learning Outcome (Practical)</b>	At the end of the course the students will be able to: <ul style="list-style-type: none"> <li>▪ Perform surface finishing operation.</li> <li>▪ Perform tool and cutter grinding machine operation.</li> <li>▪ Perform mandrel.</li> <li>▪ Perform gear blank using lathe machine.</li> <li>▪ Perform gear (helical &amp; bevel) cutting.</li> <li>▪ Perform facing, plain turning, step turning, taper turning, grooving, boring and thread cutting using CNC lathe machine.</li> <li>▪ Perform straight slotting, circular slotting, square slotting and drilling on CNC milling machine.</li> <li>▪ Perform Honing and lapping operation.</li> </ul>

## Detailed Syllabus (Theory)

Unit	Topics with contents	Period	Marks
1	<p><b>PRECISION GRINDING MACHINE</b></p> <p>1.1 Define precision grinding.</p> <p>1.2 Describe benefits and functions of precision grinding machine.</p> <p>1.3 Classify precision grinding machine.</p> <p>1.4 State safety precautions during working on precision grinding machine.</p> <p>1.5 Describe cylindrical and surface grinding operations.</p> <p>1.6 Explain center type grinding.</p> <p>1.7 Describe center less type grinding machine.</p> <p>1.8 Describe internal grinding process.</p> <p>1.9 Mention the procedure of crankshaft grinding.</p> <p>1.10 Describe pneumatic grinding.</p>	3	4
2	<p><b>TOOL AND CUTTER GRINDER.</b></p> <p>2.1 State the bonding materials of grinding wheel.</p> <p>2.2 State the principles of tool and cutter grinder.</p> <p>2.3 State safety precautions during working on tool and cutter grinder.</p> <p>2.4 Mention the main parts of tool and cutter grinder.</p> <p>2.5 Mention the Components, attachment and accessories for tool and cutter grinder.</p> <p>2.6 Describe uses of the various standard cutter grinders.</p> <p>2.7 List the various attachments of the cutter grinding wheel.</p> <p>2.8 Describe the methods of sharpening cutting tools.</p>	3	6
3	<p><b>CNC LATHE MACHINE</b></p> <p>3.1 Explain the importance of CNC lathe machine.</p> <p>3.2 Describe specification of CNC lathe machine.</p> <p>3.3 Describe are the safety precautions of CNC lathe.</p> <p>3.4 Describe alphabets notation on CNC machine.</p> <p>3.5 Illustrate machine control unit (MCU).</p> <p>3.6 Describe turret head of CNC lathe machine.</p> <p>3.7 Mention the Procedure of OFFSET of Work piece &amp; tool bit.</p> <p>3.8 Describe G- Code and M- Code.</p> <p>3.9 State the step of CNC programming.</p> <p>3.10 Mention the fault and remedy of CNC Machine.</p>	4	8
4	<p><b>CNC MILLING MACHINE.</b></p> <p>4.1 Explain the importance of CNC milling machine.</p> <p>4.2 Describe CNC milling machine with CNC milling cutter types.</p> <p>4.3 State Safety precautions during CNC milling operation.</p> <p>4.4 Mention the functions of major components of CNC milling machine.</p> <p>4.5 Describe different types of CNC milling machine &amp; types milling cutter.</p>	3	6

	<p>4.6 Mention specification of CNC milling machine.</p> <p>4.7 Describe tool magazine on CNC milling machine.</p> <p>4.8 List the Procedure of OFFSET of Work piece &amp; tool bit.</p> <p>4.9 Describe material shaped by CNC milling machine.</p> <p>4.10 State the step of CNC programming.</p>		
5	<p><b>SUPER FINISHING MACHINE.</b></p> <p>5.1 Define super finishing.</p> <p>5.2 State safety precautions during Honing and Lapping operation.</p> <p>5.3 Mention different types machines of super finishing process.</p> <p>5.4 Describe Honing operation.</p> <p>5.5 Describe purposes of honing.</p> <p>5.6 Describe lapping operation.</p> <p>5.7 Differentiate between honing, lapping &amp; super finishing operation.</p> <p>5.8 State the application of Honing and lapping.</p>	3	6
	<b>Total</b>	16	30

### Detailed Syllabus (Practical)

Sl.	Experiment name with procedure	Class (3 Period)	Marks
1	<p><b>PERFORM GRINDING ON SURFACE GRINDING MACHINE.</b></p> <p>1.1 Mount and balance the grinding wheel.</p> <p>1.2 Draw Layout work piece according to drawing.</p> <p>1.3 Select work piece material.</p> <p>1.4 Set up grinding machine &amp; work piece.</p> <p>1.5 Perform work piece grinding as per drawing.</p> <p>1.6 Clean and store tools and equipment.</p> <p>1.7 Maintain the record of performed task.</p>	2	2
2	<p><b>PERFORM GRINDING ON CYLINDRICAL GRINDING MACHINE.</b></p> <p>2.1 Set up tools and work piece on cylindrical grinding Machine</p> <p>2.2 Perform grinding on a cylindrically surface.</p> <p>2.3 Follow safety precautions of precision grinding.</p> <p>2.4 Clean and store tools and equipment.</p> <p>2.5 Maintain the record of performed task.</p>	1	3
3	<p><b>PERFORM SINGLE POINT CUTTING TOOL GRINDING ON TOOL AND CUTTER GRINDER MACHINE.</b></p> <p>3.1 Design and drawing single point cutting tool.</p> <p>3.2 Select &amp; collect tools, equipment and raw material.</p> <p>3.3 Setup machine and work piece.</p> <p>3.4 Perform grinding on single point cutting tool as per drawing</p> <p>3.5 Follow safety precautions.</p> <p>3.6 Clean and store tools and equipment.</p> <p>3.7 Maintain the record of performed task.</p>	1	3

4	<p><b>PERFORM TWIST DRILL BIT TOOL GRINDING ON TOOL AND CUTTER GRINDER MACHINE.</b></p> <p>4.1 Select &amp; collect tools, equipment and twist drill bit.  4.2 Setup machine and work piece.  4.3 Perform grinding on twist drill bit.  4.4 Follow safety precautions.  4.5 Clean and store tools and equipment.  4.6 Maintain the record of performed task.</p>	1	3
5	<p><b>PREPARE MANDREL BY LATHE MACHINE.</b></p> <p>5.1 Select tools &amp; tool bit.  5.2 Select raw material as per design.  5.3 Prepare mandrel as per design.  5.4 Clean and store tools and equipment.  5.5 Maintain the record of performed task.</p>	2	2
6	<p><b>PREPARE HELICAL GEAR BLANK.</b></p> <p>6.1 Design and calculate helical gear.  6.2 Select raw material as per design.  6.3 Prepare gear blank by Lathe machine.  6.4 Clean and store tools and equipment.  6.5 Maintain the record of performed task.</p>	2	3
7	<p><b>PERFORM HELICAL GEAR BY CONVENTIONAL MILLING OPERATION.</b></p> <p>7.1 Select and setup indexing.  7.2 Select milling cutter.  7.3 Select cutting speed.  7.4 Setup Job on indexing head.  7.5 Select and setup gear arrangement as per design.  7.6 Perform helical gear.  7.7 Clean and store tools and equipment.  7.8 Maintain the record of performed task.</p>	2	2
8	<p><b>PERFORM BEVEL GEAR USING CONVENTIONAL MILLING MACHINE</b></p> <p>8.1 Design and calculate bevel gear.  8.2 Select &amp; collect tools, equipment and raw material.  8.3 Prepare gear blank by Lathe machine  8.4 Setup indexing, milling cutter and RPM.  8.5 Setup job on indexing head.  8.6 Prepare bevel gear.  8.7 Clean and store tools and equipment.  8.8 Maintain the record of performed task.</p>	3	4
9	<p><b>DEMONSTRATE ELEMENTS OF CNC LATHE MACHINE.</b></p> <p>9.1 Identify Specification of CNC Lathe machine.  9.2 Identify different operation CNC Lathe machine.</p>	1	3

	<p>9.3 Practice Occupational Health &amp; Safety (OHS).</p> <p>9.4 Clean and store tools and equipment.</p> <p>9.5 Maintain the record of performed task.</p>		
10	<p><b>PERFORM FACING OPERATION ON CNC LATHE MACHINE.</b></p> <p>10.1 Select raw material.</p> <p>10.2 Perform program according to drawing</p> <p>10.3 Setup job on machine.</p> <p>10.4 Perform facing operation.</p> <p>10.5 Clean and store tools and equipment.</p> <p>10.6 Maintain the record of performed task.</p>	2	2
11	<p><b>PERFORM PLAIN TURNING OPERATION ON CNC LATHE MACHINE.</b></p> <p>11.1 Select raw material.</p> <p>11.2 Perform program according to drawing</p> <p>11.3 Setup job on machine.</p> <p>11.4 Perform turning operation.</p> <p>11.5 Clean and store tools and equipment.</p> <p>11.6 Maintain the record of performed task.</p>	2	2
12	<p><b>PERFORM STEP TURNING OPERATION ON CNC LATHE MACHINE.</b></p> <p>12.1 Select raw material</p> <p>12.2 Perform program according to drawing</p> <p>12.3 Setup job on machine.</p> <p>12.4 Perform Step turning operation.</p> <p>12.5 Clean and store tools and equipment.</p> <p>12.6 Maintain the record of performed task.</p>	2	3
13	<p><b>PERFORM TAPER TURNING OPERATION ON CNC LATHE MACHINE.</b></p> <p>13.1 Select raw material.</p> <p>13.2 Perform program according to drawing.</p> <p>13.3 Setup job on machine.</p> <p>13.4 Perform Taper turning operation.</p> <p>13.5 Clean and store tools and equipment.</p> <p>13.6 Maintain the record of performed task.</p>	1	2
14	<p><b>PERFORM GROOVE CUTTING ON CNC LATHE MACHINE.</b></p> <p>14.1 Select raw material.</p> <p>14.2 Perform program according to drawing.</p> <p>14.3 Setup job on machine.</p> <p>14.4 Perform groove cutting operation.</p> <p>14.5 Clean and store tools and equipment.</p>	1	2

	14.6 Maintain the record of performed task.		
15	<b>PERFORM BORE CUTTING ON CNC LATHE MACHINE.</b> 15.1 Select raw material 15.2 Perform program according to drawing 15.3 Setup job on machine. 15.4 Perform bore cutting operation. 15.5 Clean and store tools and equipment. 15.6 Maintain the record of performed task.	1	2
16	<b>DEMONSTRATE ELEMENTS OF CNC MILLING MACHINE.</b> 16.1 Identify Specification of CNC milling machine. 16.2 Identify different operation CNC Milling machine. 16.3 Practice OHS (Occupational Health & Safety). 16.4 Maintain the record of performed task.	1	3
17	<b>PERFORM STRAIGHT SLOT CUTTING ON CNC MILLING MACHINE.</b>  17.1 Perform program according to drawing 17.2 Setup job on machine. 17.3 Perform Straight slot cutting operation. 17.4 Practice workshop safety precautions of CNC Milling. 17.5 Maintain the record of performed task.	2	3
18	<b>PERFORM CIRCULAR SLOT CUTTING ON CNC MILLING MACHINE.</b>  18.1 Perform program according to drawing 18.2 Setup job on machine. 18.3 Perform Circular slot cutting operation. 18.4 Follow workshop safety precautions of CNC Milling. 18.5 Maintain the record of performed task.	2	2
19	<b>PERFORM SQUARE CUTTING ON CNC MILLING MACHINE.</b>  19.1 Perform program according to drawing. 19.2 Setup job on machine. 19.3 Perform Square slot cutting operation. 19.4 Maintain the record of performed task.	1	2
20	<b>PERFORM DRILLING ON CNC MILLING MACHINE.</b>  20.1 Perform program according to drawing. 20.2 Setup job on machine. 20.3 Perform drilling operation. 20.4 Maintain the record of performed task. 20.5 Practice workshop safety precautions of CNC Milling.	2	2
	<b>Total</b>	32	50



**Necessary Resources (Tools, equipment's and Machinery):**

Sl.	Item Name	Quantity
01	Computer	02 Nos
02	Conventional Milling Machine	3 Nos
03	Conventional Lathe Machine	10 Nos
04	CNC milling Machine	1 Nos
05	CNC lathe machine	1 Nos
06	Tool and cutter grinder	1 Nos
07	Surface grinder Machine	1 Nos
08	Cylindrical grinder machine	1 Nos
09	Vernier Calipers	10 Nos
10	Multimedia Projector	01 Nos
10	Projector screen	01 Nos
11	Honing & lapping machine	01 Nos

**Recommended Software:**

Sl	Name	Quantity
01	Solidworks, AutoCAD, AutoDesk, NX, Pro Engineering	As Necessary

**Recommended Books:**

Sl	Book Name	Writer Name	Publisher Name & Edition
01	Non-Traditional & Advanced Machining Technologies	Helmi yousef, Hassan El- hofy	CRC Press & Second Edition
02	A textbook of workshop technology	R.S Khurmi J.K Gupta	S Chand & co ltd.
03	CNC fundamentals and programming	P.M Agrawal Dr. V.j Patel	Charotar & 2 <sup>nd</sup> edition
04	Programming of CNC Machines	Ken Evans	Industrial Press, Inc.; 3 <sup>rd</sup> edition
05	Machine shop	lascoe, nelson, porter	Amer Technical Publication; 4 <sup>th</sup> Edition.

**Website References:**

Sl	Web Link	Remarks
01	<a href="http://www.youtube.com">http://www.youtube.com</a>	
02	<a href="http://www.Google.com">http://www.Google.com</a>	

Subject Code	Subject Name	Period per Week		Credit
27043	Metallurgy	T	P	C
		2	3	3

<b>Rationale</b>	<p>Diploma in mechanical engineering level students must acquire basic knowledge, skills and attitude about metallurgy. Also required basic knowledge of newly introduced mechanical technology and other related metal analysis &amp; calculation. It will enhance the capability of student.</p> <p>After successfully completing this course, students will be able to identify fundamental of metals, ferrous, non-ferrous. Composition of wrought iron, cast iron, steel and their applications. Concept and scope of metallurgy, uses of metallic ore, production of pig iron, production of wrought iron, feature of cast iron, plain carbon steel; Bessemer, Open Hearth, Crucible process for making steel, process of making steel by electric furnace, aspect of alloy steel, aspect of non-ferrous metals, feature of alloy of metals and application of powder metallurgy in engineering production.</p>
<b>Learning Outcome (Theoretical)</b>	<p><b>At the end of the course the students will be able to:</b></p> <ul style="list-style-type: none"> <li>• State concept and scope of metallurgy.</li> <li>• Describe metallic ore and refractories.</li> <li>• Illustrate production of pig iron in blast furnace.</li> <li>• Explain wrought iron with uses.</li> <li>• Mention the feature of cast iron and its uses.</li> <li>• State plain carbon steel and uses of Plain carbon.</li> <li>• Describe Bessemer, Open Hearth &amp; Crucible processes for making steel.</li> <li>• Mention the process of making steel by electric furnace.</li> <li>• Explain alloy steel, non-ferrous metals and alloy of non-ferrous metals.</li> <li>• Mention the application of powder metallurgy in engineering production.</li> </ul>
<b>Learning Outcome (Practical)</b>	<p>At the end of the course the students will be able to:</p> <ul style="list-style-type: none"> <li>• Practice occupational safety &amp; health (OSH).</li> <li>• Identify various types of metals.</li> <li>• Sketch different types of metal structure.</li> <li>• Perform Hardness test of metals using Rockwell testing machine.</li> <li>• Perform Hardness test of metals using Brinell testing machine.</li> <li>• Identify ferrous and non-ferrous metals.</li> <li>• Identify different types of alloy steel.</li> <li>• Determine the internal structure of standard specimen using metallurgical microscope.</li> <li>• Construct and operate electric furnace process of making steel.</li> <li>• Perform Compaction process in powder metallurgy.</li> </ul>

## Detailed Syllabus (Theory)

Unit	Topics with contents	Class (1 Period)	Final Marks
1	<b>CONCEPT AND SCOPE OF METALLURGY</b> 1.1 Define metallurgy. 1.2 Classify metallurgy. 1.3 State the importance of metallurgy in the engineering field. 1.4 Describe the metallurgical structure of metals. 1.5 Mention the physical and mechanical properties of metals.	2	1
2	<b>METALLIC ORE AND REFRACTORIES.</b> 2.1. Define ores of metals. 2.2. Classify ores of metals. 2.3. Describe the processing of ores before melting. 2.4. Describe metallic ores available in Bangladesh. 2.5. Define refractory materials. 2.6. Describe different types of refractories. 2.7. State characteristic of good refractories. 2.8. State function of refractories. 2.9. State refractory materials used in different furnaces.	3	6
3	<b>PIG IRON</b> 3.1 Define pig iron. 3.2 Mention the Composition of pig iron. 3.3 Define furnace. 3.4 State considering factors to identify furnace. 3.5 State various types of metal melting furnaces. 3.6 Describe the importance of blast furnace. 3.7 State construction of blast furnace. 3.8 Explain the operation of blast furnace. 3.9 Describe the chemical reaction caused in the blast furnace for pig iron production. 3.10 Describe the elements of slag used in the blast furnace.	3	8
4	<b>WROUGHT IRON</b> 4.1. Define wrought iron. 4.2. Mention the composition of wrought iron. 4.3. State the properties of wrought iron. 4.4. State the uses of wrought iron. 4.5. State manufacturing process of wrought iron. 4.6. State safety precaution for manufacturing process of wrought iron.	3	6
5	<b>CAST IRON</b> 5.1 Define cast iron. 5.2 Classify cast iron. 5.3 Mention the composition of various cast iron. 5.4 Mention the properties of various cast iron. 5.5 Explain the manufacturing process of cast iron.	3	6

	<p>5.6 Describe effect of sulfur, phosphorous, aluminum and silicon on the properties of cast iron.</p> <p>5.7 Explain the domestic and industrial uses of cast iron.</p>		
6	<p><b>PLAIN CARBON STEEL</b></p> <p>6.1 Define plain carbon steel.</p> <p>6.2 Mention different types of plain carbon steel.</p> <p>6.3 Mention the composition of plain carbon steel.</p> <p>6.4 State the uses of different plain carbon steels.</p> <p>6.5 Describe process of making steel in Bangladesh</p>	3	6
7	<p><b>BESSEMER, OPEN HEARTH &amp; CRUCIBLE PROCESSES FOR MAKING STEEL</b></p> <p>7.1 Describe the construction of Bessemer converter.</p> <p>7.2 Distinguish between the basic Bessemer process and acid Bessemer process of making steel.</p> <p>7.3 Describe the construction of open-hearth furnace.</p> <p>7.4 Describe the steel production using open hearth furnace.</p> <p>7.5 Mention the construction of crucible.</p> <p>7.6 Mention the crucible process of making steel.</p> <p>7.7 Explain the advantage of making steel by crucible process than other process.</p> <p>7.8 State the reasons of adopting the duplexing and tripling process of making steel</p>	4	6
8	<p><b>PROCESS OF MAKING STEEL BY ELECTRIC FURNACE</b></p> <p>8.1 Explain the construction of electric furnace.</p> <p>8.2 Mention the classification of electric furnace</p> <p>8.3 Mention the process of making steel by direct arc electric furnace.</p> <p>8.4 Describe the process of making steel by induction electric furnace.</p> <p>8.5 Mention the reason for superiority of electric furnace steel than others.</p>	3	6
9	<p><b>ALLOY STEEL, NON-FERROUS METALS AND ALLOY OF NON-FERROUS METALS</b></p> <p>9.1 State the purposes &amp; types of alloy steel.</p> <p>9.2 Differentiate between alloy steel and plain carbon steel.</p> <p>9.3 Describe the composition of stainless-steel, high-speed steel, tungsten steel, molybdenum steel, chromium steel, nickel steel and silicon steel.</p> <p>9.4 Describe the effect of manganese, tungsten, molybdenum, chromium, nickel, vanadium, copper, sulfur, phosphorous and silicon on the mechanical properties of alloy steel.</p> <p>9.5 Describe the domestic and industrial uses of stainless-steel, high-speed steel, tungsten steel, molybdenum steel, chromium steel, nickel steel and silicon steel.</p> <p>9.6 Mention the properties of Aluminum and Copper.</p> <p>9.7 Describe the uses of Aluminum, Copper, Zinc, Tin and Lead.</p> <p>9.8 Define alloy of metals.</p> <p>9.9 Describe the compositions, properties and uses of important alloys</p>	5	9

	of Aluminum, Copper, Zinc, Tin, Lead, Antimony and Nickel. 9.10 Mention the extraction process of Aluminum, Copper, Zinc, Tin and Lead.		
10	<b>APPLICATION OF POWDER METALLURGY IN ENGINEERING PRODUCTION</b> 10.1 Define powder metallurgy. 10.2 Mention the importance of powder metallurgy. 10.3 Explain the methods of producing metal powder. 10.4 State the methods of production of metal powder components. 10.5 Describe the special properties of metal powder products. 10.6 State the applications of metal powder products. 10.7 Mention the advantages and disadvantages of metal powder products.	3	6
	<b>Total</b>	<b>32</b>	<b>60</b>

### Detailed Syllabus (Practical)

Sl	Experiment name with procedure	Class (3 Period)	Continuous Marks
1	<b>PRACTICE OCCUPATIONAL SAFETY &amp; HEALTH (OSH).</b> 1.1 Select PPE. 1.2 Use PPE. 1.3 Follow OSH practices. 1.4 Clean work space, store tools & equipment. 1.5 Maintain the record of performed task.	1	1
2	<b>IDENTIFY METALS.</b> 2.1 Collect different types of metal in the laboratory. 2.2 Identify metals. 2.3 Perform non-destructive test and identify various types of metals. 2.4 Maintain the record of performed task.	1	1
3	<b>SKETCH METAL STRUCTURE.</b> 3.1 Select metals & drawing equipment. 3.2 Collect different types of predetermined diagram of metal structure. 3.3 Perform free hand sketch of metal structure. 3.4 Maintain the record of performed task.	1	2
4	<b>TEST HARDNESS OF METALS USING ROCKWELL MACHINE.</b> 4.1 Set up Rockwell hardness testing machine. 4.2 Perform specimen of job preparation. 4.3 Set up specimen of job on the platform of Rockwell hardness testing machine. 4.4 Perform Rockwell I hardness testing machine operation. 4.5 Take reading and calculate. 4.6 Perform Rockwell Hardness test. 4.7 Maintain the record of performed task.	1	3
5	<b>TEST HARDNESS OF METALS USING BRINEL MACHINE.</b>	1	3

	<p>5.1 Set up Brinell hardness testing machine.</p> <p>5.2 Perform specimen of job preparation.</p> <p>5.3 Set up specimen of job on the platform of Brinell hardness testing machine.</p> <p>5.4 Perform Brinell hardness testing machine operation.</p> <p>5.5 Take reading and calculate.</p> <p>5.6 Perform Brinell hardness test.</p> <p>5.7 Maintain the record of performed task.</p>		
6	<p><b>IDENTIFY FERROUS AND NON-FERROUS METALS.</b></p> <p>6.1 Select specimen of ferrous &amp; non-ferrous metals.</p> <p>6.2 Perform magnetic test.</p> <p>6.3 Maintain the record of performed task.</p>	2	3
7	<p><b>IDENTIFY ALLOY STEEL.</b></p> <p>7.1 Collect various types of alloy steels.</p> <p>7.2 Prepare specimen.</p> <p>7.3 Set up grinding machine.</p> <p>7.4 Perform grinding with Specimen.</p> <p>7.5 Identify alloy steels by sparking.</p> <p>7.6 Clean work space, store tools &amp; equipment.</p> <p>7.7 Maintain the record of performed task.</p>	1	3
8	<p><b>DETERMINE THE INTERNAL STRUCTURE OF STANDARD SPECIMEN USING METALLURGICAL MICROSCOPE.</b></p> <p>8.1 Select the specimen.</p> <p>8.2 Prepare the specimen.</p> <p>8.3 Perform etching.</p> <p>8.4 Perform metallurgical microscope operation.</p> <p>8.5 Observe and draw microstructure.</p> <p>8.6 Maintain the record of performed task.</p>	3	3
9	<p><b>OBSERVE THE CONSTRUCTION AND OPERATION OF ELECTRIC FURNACE PROCESS OF MAKING STEEL.</b></p> <p>9.1 Visit industry for electric furnace process of making steel.</p> <p>9.2 Observe the Construction and operation of electric furnace process of making steel.</p> <p>9.3 Maintain the record of performed task.</p>	3	3
10	<p><b>PERFORM COMPACTION PROCESS IN POWDER METALLURGY.</b></p> <p>10.1 Set up hydraulic press machine for compaction process.</p> <p>10.2 Prepare powder specimen.</p> <p>10.3 Place the powder of specimen in the molding box (die &amp; punch).</p> <p>10.4 Set up Molding box (die &amp; punch) on the platform of Hydraulic press machine.</p> <p>10.5 Perform machine operation.</p> <p>10.6 Clean work space, store tools &amp; equipment.</p> <p>10.7 Maintain the record of performed task.</p>	2	3
	<b>Total</b>	<b>16</b>	<b>25</b>

### **Necessary Resources (Tools, equipment's and Machinery):**

Sl.	Item Name	Quantity
01	Rockwell hardness testing machine	Each item 5 Nos.
02	Brinell hardness testing machine	Each item 5 Nos.
03	Metal structure diagram	Each item 5 Set.
04	Hand grinding machine	Each item 5 Nos.
05	Pedestal grinding machine	Each item 2 Nos
06	Metallurgical microscope	Each item 2 Nos.
07	Compaction hydraulic press machine	Each item 2 Nos.
08	Laptop, Multimedia & Hi-speed internet connection.	Each item 2 Nos.

### **Recommended Books:**

Sl.	Book Name	Writer Name	Publisher Name & Edition
01	Metallurgy	Johnson & Weeks	5th
02	Emergency Metallurgy	Frier	
03	Metallurgy	Jain	
04	Metallurgy	R S Khurmi	
05	Introduction to Physical Metallurgy	Sidney H. Avner	
06	Material Science and Metallurgy	O P Khanna	

Sl.	Web Link	Remarks
01	<a href="https://stu.westga.edu/~bthibau1/MEDT%207477-Cooper/Calibre%20Library/Dieter_%20George%20Ellwood/Mechanical%20metallurgy%20(13)/Mechanical%20metallurgy%20-%20Dieter_%20George%20Ellwood.pdf">https://stu.westga.edu/~bthibau1/MEDT%207477-Cooper/Calibre%20Library/Dieter_%20George%20Ellwood/Mechanical%20metallurgy%20(13)/Mechanical%20metallurgy%20-%20Dieter_%20George%20Ellwood.pdf</a>	Mechanical Metallurgy
02	<a href="https://en.wikipedia.org/wiki/Occupational_safety_and_health">https://en.wikipedia.org/wiki/Occupational_safety_and_health</a>	Occupational safety & health (OSH)
03	<a href="https://en.wikipedia.org/wiki/Metallurgy">https://en.wikipedia.org/wiki/Metallurgy</a>	Concept and scope of metallurgy
04	<a href="https://www.ispatguru.com/introduction-to-refractories/">https://www.ispatguru.com/introduction-to-refractories/</a>	Metallic ore and refractories
05	<a href="https://www.smtel.com/products/?gclid=CjwKCAiApvebBhAvEiwAe7mH5Oh6Lu9I4hni7ROlrzuxaAVMoXhngevf7tgjNffbQghAFuohJT-YBhoCP0UQAvD_BwE">https://www.smtel.com/products/?gclid=CjwKCAiApvebBhAvEiwAe7mH5Oh6Lu9I4hni7ROlrzuxaAVMoXhngevf7tgjNffbQghAFuohJT-YBhoCP0UQAvD_BwE</a>	Production of pig iron in blast furnace
06	<a href="https://www.intechopen.com/chapters/54457">https://www.intechopen.com/chapters/54457</a>	Application of powder metallurgy in engineering production
07	<a href="https://www.google.com/">https://www.google.com/</a>	Google
08	<a href="https://www.youtube.com/">https://www.youtube.com/</a>	YouTube

### **Website References:**

Sl.	Web Link	Experiment name with procedure	Remarks
01	<a href="https://www.youtube.com/watch?v=aEipqFqW6PI">https://www.youtube.com/watch?v=aEipqFqW6PI</a>	Occupational safety & health (OSH) in TVET	
02	<a href="https://www.youtube.com/watch?v=GnSBSKTC834">https://www.youtube.com/watch?v=GnSBSKTC834</a>	Identify different types of alloy steel.	

03	<a href="https://www.youtube.com/watch?v=UgmlmDUhR6A">https://www.youtube.com/watch?v=UgmlmDUhR6A</a>	Identify ferrous and nonferrous metals.	
04	<a href="https://www.youtube.com/watch?v=Mz-o0pqtWoM">https://www.youtube.com/watch?v=Mz-o0pqtWoM</a>	Hardness test of metals using brinel machine.	
05	<a href="https://www.youtube.com/watch?v=yYlh25-u5XM">https://www.youtube.com/watch?v=yYlh25-u5XM</a>	Hardness test of metals using Rockwell machine	
06	<a href="https://www.youtube.com/watch?v=QgtAlhzNeaU">https://www.youtube.com/watch?v=QgtAlhzNeaU</a>	Construction and operation of electric furnace process of making steel	
07	<a href="https://www.youtube.com/watch?v=vVm0ZW9zBtQ">https://www.youtube.com/watch?v=vVm0ZW9zBtQ</a>	Determine the internal structure of standard specimen using metallurgical microscope	
08	<a href="https://www.youtube.com/watch?v=PaGJwOPg2kU">https://www.youtube.com/watch?v=PaGJwOPg2kU</a>	Sketch different types of metal structure	
09	<a href="https://www.youtube.com/watch?v=NFOjLzmatLE">https://www.youtube.com/watch?v=NFOjLzmatLE</a>	Compaction process in Powder Metallurgy	



Subject Code	Subject Name	Period Per Week		Credit
27131	ENGINEERING THERMODYNAMICS	T	P	C
		3	3	4

<b>Rationale</b>	<p>Thermodynamics now provides essential concepts and methods for addressing critical twenty-first-century issues, such as using fossil fuels more effectively, fostering renewable energy technologies and developing more fuel-efficient means of transportation.</p> <p>Thermodynamics is a very important branch of both physics and chemistry. It deals with the study of energy, the conversion of energy between different forms and the ability of energy to do work.</p> <p>Thermodynamics is the study of the relationship between properties of heat, temperature, energy, and work. Laws of thermodynamics are the concepts of entropy and the Internal energy formula.</p> <p>Thermodynamics principles are used by mechanical engineers in the fields of heat conversion. Mechanical engineers use thermo-science to design engines and power plants, heating, ventilation and air conditioning (HVAC) systems, heat exchanger, heat sinks, radiators, refrigeration, insulation and others.</p> <p>Thermodynamics plays a major part in the design and analysis of automotive engines, rockets, jet engines, and conventional or nuclear power plants, solar collectors, and the design of vehicles from ordinary cars to aeroplanes.</p> <p>Thermodynamics gives the foundation for heat engines, power plants, chemical reactions, refrigerators, and many more important concepts that the world we live in today relies on.</p>
<b>Learning Outcome (Theoretical)</b>	<p><b>After completing the subject student will be able to</b></p> <ul style="list-style-type: none"> <li>• Explain several fundamental concepts including closed system, control volume, boundary and surroundings, property, state and process.</li> <li>• State distinction between extensive, intensive properties and equilibrium.</li> <li>• Describe various types of units for specific volume, pressure and temperature.</li> <li>• Describe the relationship among the Kelvin, Rankine, Celsius, and Fahrenheit temperature scales.</li> <li>• Explain key concepts related to energy and the first law of thermodynamics.</li> <li>• Explain internal, kinetic, and potential energy, work and power, heat transfer and heat transfer modes, heat transfer rate, power cycle, refrigeration cycle, and heat pump cycle.</li> <li>• Distinguishing between steady-state and transient analysis, between mass flow rate and volumetric flow rate.</li> <li>• Develop appropriate engineering models for control volumes, with particular attention to analyzing components commonly encountered in engineering practice such as nozzles, diffusers, turbines, compressors, heat exchangers, throttling devices, and integrated systems that incorporate two or more components.</li> <li>• Explain key concepts related to the second law of thermodynamics.</li> </ul>

<b>Learning Outcome (Practical)</b>	<b>After undergoing the subject students will be able to</b> <ul style="list-style-type: none"><li>• Verify First of law of thermodynamics.</li><li>• Verify Second of law of thermodynamics.</li><li>• Compare Otto and Diesel cycles.</li><li>• Compare various heat exchangers.</li><li>• Identify four stroke Otto cycle Diesel cycle with engine</li><li>• Perform mechanical equivalent with Joules Operator</li><li>• Perform heat transfer mode.</li><li>• Perform Rankin Cycle with steam turbine model.</li></ul>
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## Detailed Syllabus (Theory)

Unit	Topics with contents	Class (1 Period)	Final Marks
1	<p><b>Concepts of Thermodynamics</b></p> <p>1.1 Define thermodynamic, system, boundary, surroundings and the universe.</p> <p>1.2 Mention types of systems.</p> <p>1.3 Describe close, open, isolated, flow, non-flow systems.</p> <p>1.4 Mention the applications of thermodynamics in the engineering field.</p> <p>1.5 Explain the extensive &amp; intensive properties of thermodynamics systems</p> <p>1.6 Mention the units of thermodynamics systems.</p> <p>1.7 State thermodynamic state, path, process, quasi-static process, reversible &amp; irreversible process and Thermodynamics equilibrium.</p> <p>1.8 Define point function, path function and control volume.</p>	3	6
2	<p><b>Heat, Temperature and Pressure</b></p> <p>2.1 Define heat, temperature and pressure.</p> <p>2.2 Explain different types of heat, temperature scale and pressure.</p> <p>2.3 Mention the units of heat, temperature scale and pressure.</p> <p>2.4 Convert one unit to another unit of heat, temperature scale and pressure.</p> <p>2.5 Distinguish between heat and temperature.</p> <p>2.6 Explain heat is a low-grade energy and work is a high-grade energy.</p> <p>2.7 Solve problems on heat, temperature scale and pressure.</p>	3	6
3	<p><b>ZerOTH Law and First law of thermodynamics</b></p> <p>3.1 State the Zeroth law of thermodynamics.</p> <p>3.2 Mention the First law of thermodynamics.</p> <p>3.3 Describe the First law of thermodynamics</p> <p>3.4 Explain the limitation of First law of thermodynamics.</p> <p>3.5 State the corollaries of First law of thermodynamics.</p> <p>3.6 Describe the first law closed system application.</p> <p>3.7 Describe the first law open system application.</p>	3	5
4	<p><b>Second law of thermodynamics</b></p> <p>4.1 State the 2<sup>nd</sup> law of thermodynamics.</p> <p>4.2 Explain the 2<sup>nd</sup> law of thermodynamics.</p> <p>4.3 Explain the limitation of 2<sup>nd</sup> law of thermodynamics.</p> <p>4.4 State the corollaries of 2<sup>nd</sup> law of thermodynamics.</p> <p>4.5 Describe the physical significance of 1<sup>st</sup> and 2<sup>nd</sup> law of thermodynamics.</p>	4	7

	<p>4.6 State the 3<sup>rd</sup> law of thermodynamics.</p> <p>4.7 Solve problems on the laws of thermodynamic.</p>		
5	<p><b>Internal energy and enthalpy of gases</b></p> <p>5.1 Define internal energy.</p> <p>5.2 Define enthalpy &amp; specific enthalpy.</p> <p>5.3 Explain the internal energy of a gas heated at constant volume and constant pressure.</p> <p>5.4 Relate between internal energy and enthalpy.</p> <p>5.5 Explain Joule's law.</p> <p>5.6 Solve problems on change of internal energy and enthalpy of gases.</p>	3	6
6	<p><b>Thermodynamic processes of perfect gases</b></p> <p>6.1 State thermodynamic processes.</p> <p>6.2 Explain the flow processes and non-flow processes of gases.</p> <p>6.3 Describe the various non-flow thermodynamic processes with P-V and T-S diagrams.</p> <p>6.4 Determine the work done by the gases during the above process.</p> <p>6.5 Explain the steady and unsteady flow processes.</p> <p>6.6 Describe the steady flow energy equations.</p> <p>6.7 Solve problems on thermodynamic processes.</p>	3	6
7	<p><b>Entropy of perfect gases</b></p> <p>7.1 Define entropy.</p> <p>7.2 State the importance of entropy.</p> <p>7.3 Describe the principle of increase of entropy.</p> <p>7.4 Explain the relation between heat &amp; entropy.</p> <p>7.5 Describe the general expression for change of entropy of a perfect gas during various thermodynamic processes.</p> <p>7.6 Solve problems on entropy of different thermodynamic processes.</p>	3	5
8	<p><b>Steam and Vapor</b></p> <p>8.1 Mention the three-state of a substance.</p> <p>8.2 Distinguish between steam and vapors.</p> <p>8.3 Discuss the triple point of a substance.</p> <p>8.4 List the properties of vapors.</p> <p>8.5 Explain the formation of steam at constant pressure.</p> <p>8.6 Describe wet steam, dry saturated steam, superheated steam, dryness fraction, specific volume of steam.</p>	3	6
9	<p><b>Thermodynamic cycles</b></p> <p>9.1 Define thermodynamic cycle.</p> <p>9.2 Classify the thermodynamic cycle</p>	3	6

	9.3 Explain the reversible and irreversible cycles.		
<b>10</b>	<p><b>Air standard cycles</b></p> <p>10.1 Define Air Standard Cycle.</p> <p>10.2 Describe the Carnot cycle with P-V and T-S diagrams.</p> <p>10.3 Calculate air standard efficiencies of Carnot cycles.</p> <p>10.4 State Otto cycle, Diesel cycle with P-V and T-S diagrams of conventional air cycles.</p> <p>10.5 Explain the air standard efficiency of Otto cycle, Diesel cycle.</p> <p>10.6 Compare Otto and Diesel cycles.</p> <p>10.7 Compare the theoretical Otto and Diesel cycles with the actual Otto and Diesel cycles.</p> <p>10.8 Solve problems on different air cycles.</p>	<b>4</b>	<b>7</b>
<b>11</b>	<p><b>Vapor power cycles</b></p> <p>11.1 Define vapor power cycle.</p> <p>11.2 Describe the Rankin cycle with incomplete evaporation and modified Rankine cycle with superheated steam.</p> <p>11.3 Define reheat, regenerative and reheat-regenerative vapor cycles.</p> <p>11.4 Explain the reheat, regenerative and reheat-regenerative vapor cycles with P-V and T-S diagrams.</p> <p>11.5 Distinguish among the reheat, regenerative and reheat-regenerative vapor cycles.</p> <p>11.6 Describe the binary vapor cycle and topping cycle.</p>	<b>3</b>	<b>6</b>
<b>12</b>	<p><b>Heat engine, refrigeration and heat pumps</b></p> <p>12.1 State heat engine, refrigeration and heat pump.</p> <p>12.2 Describe the reverse cannot cycle with P-V and T-S diagrams.</p> <p>12.3 Describe the vapor compression mechanical refrigeration cycle.</p> <p>12.4 Calculate the Coefficient of performance COP (heating &amp; refrigerating)</p> <p>12.5 Describe the capacity of the refrigerating machine.</p> <p>12.6 Describe the vapor absorption refrigeration cycle.</p> <p>12.7 Solve problems on COP and TR.</p>	<b>3</b>	<b>6</b>

<b>13</b>	<b>IC engines</b> 13.1 Define IC engine. 13.2 Classify the IC engine on the basis of different terms. 13.3 Explain the terms bore and stroke, piston displacement, clearance volume and compression ratio. 13.4 List the moving parts and stationary parts of an IC engine. 13.5 Mention the function of stationary and moving parts of an IC engine. 13.6 State the working principle of 2-stroke and 4-stroke SI & CI engines. 13.7 Compare the 2-stroke and 4-stroke engines.	<b>4</b>	<b>6</b>
<b>14</b>	<b>Heat transfer</b> 14.1 Explain the three modes of heat transfer. 14.2 Distinguish among conduction, convection and radiation of heat. 14.3 Explain Fourier's law of thermal conductivity. 14.4 Explain Newton's law of cooling for convective heat transfer. 14.5 State Stefan-Boltzmann law of heat radiation. 14.6 Define heat exchanger. 14.7 Classify heat exchangers. 14.8 Explain Radiator, condenser and Evaporator of heat exchangers.	<b>3</b>	<b>6</b>
<b>15</b>	<b>Boiler.</b> 15.1 Define boiler. 15.2 Classification of boilers. 15.3 Discuss the different types of boiler 15.4 Mention the utility of boiler. 15.5 State the operational procedure of boiler operation. 15.6 Merits and demerits of fire tube and water tube boiler. 15.7 Explain boiler efficiency.	<b>3</b>	<b>6</b>
	<b>Total</b>	<b>48</b>	<b>90</b>

### Detailed Syllabus (Practical)

<b>Sl No</b>	<b>Experiment name with procedure</b>	<b>Class (3 Period)</b>	<b>Continuous Marks</b>
<b>1</b>	<b>Verify First Law of thermodynamics with I.C. Engine</b> 1.1 Collect an IC engine and required tools & equipment's. 1.2 Loosen nut-bolt and separate engine head. 1.3 Identify the different pressure volume and	<b>1</b>	<b>2</b>

	<p>temperature.</p> <p>1.4 Note down observation.</p> <p>1.5 Apply the First Law.</p> <p>1.6 Draw the PV and TS Diagram.</p> <p>1.7 Re-install engine head.</p> <p>1.8 Maintain the record of perform task</p>		
<b>2</b>	<p><b>Verify Second Law thermodynamics with I.C. Engine</b></p> <p>2.1 Collect an IC engine and required tools &amp; equipment's.</p> <p>2.2 Loosen nut-bolt and separate engine head.</p> <p>2.3 Identify the different pressure volume and temperature.</p> <p>2.4 Note down observation.</p> <p>2.5 Apply the Second Law.</p> <p>2.6 Draw the PV and TS Diagram.</p> <p>2.7 Re-install engine head.</p> <p>2.8 Maintain the record of perform task</p>	<b>2</b>	<b>3</b>
<b>3</b>	<p><b>Verify the second law of thermodynamics with the refrigeration cycle</b></p> <p>3.1 Collect a Refrigerator and required tools &amp; equipment's.</p> <p>3.2 open the back cover.</p> <p>3.3 Connect the combined pressure gauge to the compressor.</p> <p>3.4 Collect the data of different pressure and temperature.</p> <p>3.5 Note down observation.</p> <p>3.6 Apply the Second Law.</p> <p>3.7 Draw the PV and TS Diagram.</p> <p>3.8 Maintain the record of perform task</p>	<b>2</b>	<b>3</b>
<b>4</b>	<p><b>Compare Otto and Diesel cycles</b></p> <p>4.1 Collect a Petrol Engine.</p> <p>4.2 Collect a Diesel Engine.</p> <p>4.3 Collect Pressure gauge and Temperature gauge.</p> <p>4.4 Collect Temperature</p> <p>4.5 Identify the different pressure volume and temperature.</p> <p>4.6 Record the data</p> <p>4.7 Draw the PV and TS Diagram.</p>	<b>2</b>	<b>3</b>

	4.8 Maintain the record of perform task		
<b>5</b>	<b>Compare radiators, evaporators and condensers of heat exchangers</b> 5.1 Collect a Refrigerator from Lab. 5.2 Collect a Diesel Engine. 5.3 Connect the Pressure gauge and Temperature gauge to Refrigerator and diesel engine. 5.4 Collect the data of Temperature and pressure from required instrument. 5.5 Record the data 5.6 Compare heat exchange of different instrument from collect data. 5.7 Maintain the record of perform task.	<b>2</b>	<b>3</b>
<b>6</b>	<b>Demonstrate the 4-stroke Otto Cycle with an engine</b> 6.1 Collect a 4-stroke petrol engine model. 6.2 Operate crank handle up to piston move TDC position. 6.3 Observe piston at TDC position intake valve open & exhaust valve closed position. 6.4 Operate crank handle until end of suction stroke (Piston at BDC position). 6.5 Operate crank handle until end of compression stroke and observe piston and valves position. 6.6 Operate crank handle up to end of expansion stroke and observe piston and valves position. 6.7 Operate crank handle up to end of exhaust stroke and observe piston and valves position. 6.8 After one cycle complete then draw P-V diagram of Otto cycle. 6.9 Maintain the record of perform task.	<b>2</b>	<b>2</b>
<b>7</b>	<b>Demonstrate the 4-stroke Diesel Cycle with an engine</b> 7.1 Collect a 4-stroke diesel engine. 7.2 Operate crank handle up to piston move TDC position. 7.3 Observe piston at TDC position intake valve open & exhaust valves closed position. 7.4 Operate crank handle until end of suction stroke (Piston at BDC position). 7.5 Operate crank handle until end of compression stroke and observe piston and valves position. 7.6 Operate crank handle up to end of expansion	<b>2</b>	<b>3</b>



	<p>7.7 stroke and observe piston and valves position. Operate crank handle up to end of exhaust stroke and observe piston and valves position.</p> <p>7.8 After one cycle complete then draw P-V diagram of diesel cycle.</p> <p>7.9 Maintain the record of perform task.</p>		
<b>8</b>	<p><b>Determine the mechanical equivalent of heat by Joule's apparatus</b></p> <p>8.1 Collect a Joule's apparatus.</p> <p>8.2 Connect pressure pump with apparatus.</p> <p>8.3 Note the fluid pressure and volume.</p> <p>8.4 Create pressure by hand pumper.</p> <p>8.5 Note the fluid pressure and volume (at least 5 reading).</p> <p>8.6 Draw volume-pressure diagram &amp; volume inverse pressure diagram.</p> <p>8.7 Maintain the record of perform task.</p>	<b>1</b>	<b>2</b>
<b>9</b>	<p><b>Demonstrate the heat transfer modes Conduction, convention and radiation with refrigerator</b></p> <p>9.1 Collect a Refrigerator.</p> <p>9.2 Note down Primary temperature.</p> <p>9.3 Apply heating or Cooling Process</p> <p>9.4 Write three modes final temperature.</p> <p>9.5 Maintain the record of perform task.</p>	<b>1</b>	<b>2</b>
<b>10</b>	<p><b>Observe Rankin cycle with a steam turbine model</b></p> <p>10.1 Collect a pot to produce Steam.</p> <p>10.2 Collect a burner for heat.</p> <p>10.3 Collect a turbine model.</p> <p>10.4 Observe different parts of turbine model.</p> <p>10.5 Apply the method of Rankin Cycle.</p> <p>10.6 Visit a related industry.</p> <p>10.7 Maintain the record of perform task.</p>	<b>1</b>	<b>2</b>
	<b>Total</b>	<b>16</b>	<b>25</b>

### Recommended Books:

Sl	Book Name	Writer Name	Publisher Name & Edition
<b>01</b>	Engineering Thermodynamics	P.K. Nag,	Tata McGraw-Hill, New Delhi
<b>02</b>	Engineering Thermodynamics	R.K. Rajput,	Laxmi Publications, New Delhi
<b>03</b>	Fundamentals of Engineering Thermodynamics	R.Yadav	Central Publishing House, Allahabad.
<b>04</b>	Thermodynamics – An	Yunus Centel & Boles	Tata Mc Graw-Hill, New Delhi.

	Engineering Approach		
05	Thermodynamics	J.P. Holman	Tata Mc Graw-Hill, New Delhi.
6	Engineering Thermodynamics	Rogers G.F.C. & Mayhew Y.R.	Tata Mc Graw-Hill, New Delhi.

### **Necessary Resources (Tools, equipment's and Machinery):**

SI	Item Name	Quantity
01	Socket Set	24 pc
02	Ring wrench	1 set
03	Combination wrench	1 set
04	Flat, Star Screw Driver	1 set
05	Diesel Engine Model	5 pc
06	Petrol Engine Model	5 pc
07	Refrigerator	5 pc
08	Air Compressor	5 pc
09	Radiator	5 pc
10	Evaporator	5 pc
11	Condenser	5 pc
12	Pressure Gauge	5 pc
13	Temperature Gauge	5 pc
14	Steam turbine model	5 pc

### **Website References:**

SI	Web Link	Remarks
01	<a href="https://youtu.be/7iA6dkaXYoo">https://youtu.be/7iA6dkaXYoo</a>	First law of thermodynamics
02	<a href="https://youtu.be/1OFIW8OXN6">https://youtu.be/1OFIW8OXN6</a>	First law of thermodynamic
02	<a href="https://youtu.be/WTtxlaeC9PY">https://youtu.be/WTtxlaeC9PY</a>	2 <sup>nd</sup> law of thermodynamics
03	<a href="https://www.youtube.com/watch?v=w6VNUYIUV3s">https://www.youtube.com/watch?v=w6VNUYIUV3s</a>	2 <sup>nd</sup> law of thermodynamics
04	<a href="https://www.youtube.com/watch?v=FTSBtx5jhaY">https://www.youtube.com/watch?v=FTSBtx5jhaY</a>	Heat Transfer mode conduction..
05	<a href="https://www.youtube.com/watch?v=HpCvWuvCUoA">https://www.youtube.com/watch?v=HpCvWuvCUoA</a>	Mode of heat transfer
06	<a href="https://www.youtube.com/watch?v=le-z0mPfmZo">https://www.youtube.com/watch?v=le-z0mPfmZo</a>	Rankine cycle of steam turbine
07	<a href="https://youtu.be/Wd29UzYHJt0">https://youtu.be/Wd29UzYHJt0</a>	Otto Cycle
08	<a href="https://youtu.be/hclxVynxCyl">https://youtu.be/hclxVynxCyl</a>	Diesel Cycle
09	<a href="https://youtu.be/TBEEt8x4nSo">https://youtu.be/TBEEt8x4nSo</a>	Refrigeration Cycle
10	<a href="https://youtu.be/VqUAhrrW6UA">https://youtu.be/VqUAhrrW6UA</a>	Joule's apparatus.

Subject Code	Subject Name	Period per Week		Credit
29061	Environmental Studies	T	P	C
		2	3	3

<b>Rationale</b>	<p>The need for sustainable environmental development is critical for the future of the world and mankind. The excess demand of natural resources is creating obstacles to sustain life on earth. The continuing problems of pollution have made everyone aware of environmental issues. Different industrial sectors have direct impact on the environment and are responsible for air, water, soil, noise, marine, nuclear, and biological pollution. The knowledge of environmental studies is the prerequisite for the control of these pollutions. In this present scenario, fundamental knowledge of environmental studies is necessary for a Diploma in Engineering Course to understand the root causes of pollution and enable them to control industrial pollution through maintaining the raw materials, processes, and technology.</p> <p>The subject covers the basic knowledge about key environmental issues, different types of pollution, their effects, control measures, and remedies in their respective fields. This will enable them to be responsible professionals and contribute to sustainable development for the benefit of all.</p> <p>This module is designed with hands on practical approach which includes practical activity to identify common pollutants and data collection for resource consumption.</p>
<b>Learning Outcome (Theoretical)</b>	<p><b>After undergoing the subject, students will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Describe the environment and environmental pollution.</li> <li>2. Explain ecology and ecosystems.</li> <li>3. Identify major environmental risks and challenges. related to industrial operation, production, and agriculture.</li> <li>4. Identify ways to mitigate negative effects on the environment.</li> <li>5. State Legislative measures and requirements to protect the environment.</li> </ol>
<b>Learning Outcome (Practical)</b>	<p><b>After undergoing the subject, students will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Analyze the water and wastewater quality parameters.</li> <li>2. Demonstrate the air quality measures.</li> <li>3. Estimate the noise level and acoustic zone mapping.</li> <li>4. Collect data for resource consumption and waste generation.</li> <li>5. Observe operations of an Effluent water treatment plant (ETP).</li> </ol>

## Detailed Syllabus (Theory)

Unit	Topics with Contents	Class (1 Period)	Final Marks
1	<p><b>INTRODUCTION TO ENVIRONMENTAL STUDIES</b></p> <p>1.1 Define nature, environment &amp; environmental studies.            1.2 Mention the components of the environment.            1.3 Define pollution, pollutant &amp; contaminant.            1.4 Classify different types of pollution.            1.5 Differentiate between natural and man-made environments.            1.6 Define climate change.            1.7 Mention the impact of climate change.</p>	2	4
2	<p><b>ECOLOGY &amp; ECOSYSTEM</b></p> <p>2.1 Define ecology &amp; eco-system.            2.2 Illustrate the water cycle.            2.3 Illustrate the carbon cycle.            2.4 Illustrate the nitrogen cycle.            2.5 Illustrate the oxygen cycle.            2.6 Define food chains and food webs.            2.7 Define Biodiversity, biomass, bioconcentration and bio magnification.            2.8 Describe Terrestrial and Aquatic ecosystem.            2.9 Define ecologically critical area (ECA), threatened species, endanger species, extinct species, and exotic species.            2.10 List the ecologically critical areas of Bangladesh.</p>	2	4
3	<p><b>GLOBAL AND NATIONAL ENVIRONMENTAL ISSUES</b></p> <p>3.1. Define Greenhouse effect, global warming &amp; Ozone depleting substances (ODS).            3.2. Mention the causes of global warming.            3.3. List the greenhouse gases.            3.4. State the contribution of greenhouse gases to the greenhouse effect.            3.5. Discuss the effects of global warming on the environment and human life.            3.6. Define acid rain and impact on the environment.            3.7. Describe the importance of the ozone layer and the effects of ozone depletion.            3.8. Mention different types of natural disaster.            3.9. Discuss the Flood, Cyclone &amp; Earthquake disaster management system of Bangladesh.</p>	3	6
4	<p><b>WATER AND WASTEWATER MANAGEMENT</b></p> <p>4.1 Define water pollution, water pollutants and pollution sources.            4.2 Mention the sources of water pollution.            4.3 Mention the quality standards of drinking water and wastewater.            4.4 Define wastewater management.            4.5 Explain effluents, influent and methods of effluent treatment.            4.6 Draw different schematic diagrams of effluent treatment methods.            4.7 Explain the effects of water pollution on human health and the</p>	5	10

	environment. 4.8 Discuss the importance of water conservation.		
5	<b>AIR POLLUTION, ENERGY AND CARBON FOOTPRINT</b>  5.1 Describe the sources, production, and consumption of energy. 5.2 Describe air pollution and sources of air pollution. 5.3 Define Carbon Footprint. 5.4 Define GHG emission and contribution to the greenhouse effect. 5.5 Discuss the effects of energy consumption on Climate Change. 5.6 Explain the concept of energy efficiency. 5.7 Discuss Carbon Footprint calculation methods. 5.8 Discuss the importance of reducing Carbon Footprint. 5.9 Discuss the effect of air pollution on human health, vegetation, and animals.	5	8
6	<b>NOISE POLLUTION</b>  6.1 Define sound & sound wave. 6.2 Mention the scale of measuring sound intensity. 6.3 Define sound pressure & sound power. 6.4 Describe the sound intensity and loudness. 6.5 Define noise pollution. 6.6 Mention the sources of noise pollution. 6.7 Mention the effect of noise pollution on human health. 6.8 Explain the methods for noise prevention in the industry.	2	4
7	<b>SOIL POLLUTION</b>  7.1. Define soil pollution and soil degradation. 7.2. Classify different types of soil pollution. 7.3. Mention the sources of soil pollution. 7.4. List the main pollutants in soil. 7.5. Describe the impacts of soil pollution on the food chain and ecosystem. 7.6. Describe the methods of soil pollution controlling. 7.7. List the agro-ecological zones of Bangladesh.	2	4
8	<b>SOLID WASTE MANAGEMENT</b>  8.1 Define solid waste. 8.2 Identify the sources of solid waste. 8.3 Categorize different types of solid waste. 8.4 Discuss the solid waste collection methods. 8.5 Describe 3R and 4R methods of solid waste management. 8.6 Describe the potential method of disposal of solid waste. 8.7 Mention the waste management strategies in Bangladesh. 8.8 Discuss the impact of solid waste on environment and human health.	3	6
9	<b>CHEMICAL MANAGEMENT</b>  9.1 Define Chemical hazard. 9.2. Discuss different types of chemical hazard and toxicity. 9.3 State the benefits of chemical management. 9.4 Describe basic concepts of chemical segregation and storage. 9.5. Describe chemical label and safety data sheet (SDS) 9.6. Discuss different hazard pictogram and safety signs. 9.7 Describe chemical pesticides.	4	7

	9.8. Describe the mitigation and control measures of chemical exposure.		
10	<p><b>REGULATORY ISSUES OF ENVIRONMENT</b></p> <p>10.1 Mention environmental act &amp; legislations prescribed for air, noise, water, soil &amp; wildlife protection in Bangladesh.</p> <p>10.2 Discuss International protocols and agreements related to environmental issues.</p> <p>10.3 Define environmental impact assessment (EIA).</p> <p>10.4 Describe the environmental framework in Bangladesh.</p> <p>10.5 Describe environmental conservation act 1995 in Bangladesh.</p> <p>10.6 Describe the environment conservation rule 1997 in Bangladesh.</p> <p>10.7 Discuss the steps required to obtain Environmental Clearance certificate in Bangladesh.</p>	<b>4</b>	<b>7</b>
	<b>Total</b>	<b>32</b>	<b>60</b>

### Detailed Syllabus (Practical)

Sl.	Experiment name with procedure	Class (3 Period)	Total Marks
1	<p><b>Determine physical water quality of water sample.</b></p> <p>1.1 Measure temperature, color, odor &amp; taste.</p> <p>1.2 Measure turbidity of water.</p> <p>1.3 Measure total suspended solids (TSS) present in water sample.</p> <p>1.4 Maintain the record of performed job.</p>	1	5
2	<p><b>Determine chemical water quality of water sample.</b></p> <p>2.1 Measure pH level in water sample.</p> <p>2.2 Measure Hardness in water sample.</p> <p>2.3 Maintain the record of performed job.</p>	1	5
3	<p><b>Measure total dissolved solids (TDS) present in water sample.</b></p> <p>3.1 Prepare TDS meter &amp; necessary accessories.</p> <p>3.2 Read the value of TDS meter.</p> <p>3.3 Maintain the record of performed job.</p>	1	5
4	<p><b>Determine Iron (Fe) &amp; Arsenic (As) level in water sample.</b></p> <p>4.1 Prepare Iron &amp; Arsenic test kit bottles.</p> <p>4.2 Measure Iron (Fe) level in water sample.</p> <p>4.3 Measure Arsenic level in water sample.</p> <p>4.4 Maintain the record of performed job.</p>	1	5
5	<p><b>Determine dissolved oxygen (DO), Chemical oxygen demand (COD), biochemical oxygen demand (BOD) in wastewater sample.</b></p> <p>5.1 Prepare DO meter and necessary accessories.</p> <p>5.2 Measure dissolved oxygen (DO) level present in water.</p> <p>5.3 Measure biochemical oxygen demand (BOD) in water.</p> <p>5.4 Prepare required apparatus for Chemical oxygen demand (COD) test.</p> <p>5.5 Prepare reagents for COD test.</p> <p>5.6 Observe COD test readings and calculate result.</p>	1	5

	5.7 Maintain the record of performed job.		
6	<b>Measure Air Quality</b> 6.1 Prepare air quality meter and necessary accessories. 6.2 Measure air quality, CO <sub>2</sub> level in the air. 6.3 Maintain the record of performed job.	1	5
7	<b>Control of air dust by cyclone separator</b> 7.1 Prepare cyclone separator. 7.2 Observe the reading of cyclone separator. 7.3 Remove the dust from cyclone separator. 7.4 Maintain the record of performed job.	1	5
8	<b>Measurement of noise level in different places</b> 8.1 Prepare noise meter. 8.2 Observe the reading of noise level meter. 8.3 Measure the noise level in different working area. 8.4 Maintain the record of performed job.	1	5
9	<b>Calculate Energy consumption.</b> 9.1 Collect the data. 9.2 Compute energy consumption in KWH. 9.3 Maintain the record of performed job.	1	5
10	<b>Perform a field visit on Effluent treatment plant (ETP)</b> 10.1 Observe the ETP plant. 10.2 Collect the relative data. 10.3 Prepare the diagram of observed ETP plant. 10.4 Maintain the record of performed job.	1	5
	<b>Total</b>	<b>10</b>	<b>50</b>

### Necessary Resources (Tools, equipment's, and Machinery):

Sl	Item Name	Quantity
01	Turbidity meter	5 set
02	P <sup>H</sup> meter	5 set
03	TDS meter	5 set
04	Noise Level Meter	5 set
05	DO meter	5 set
06	Cyclone Separator(high sampler)	5 set
07	Iron & Arsenic test kit box	5 set
08	Incubator	1 set
09	Water Bath	1 set
10	Glassware	5 set
11	Thermometer	5 set
12	Ultraviolet–visible Spectrophotometer	1 set
13	Energy meter	1 set
14	Bill or data for electricity bill, gas bill, liquid gas bill, gasoline bill	5 sets for each class
15	AMP meter	5 set
16	High volume sampler	1 set
17	Oven	1 set
18	Measurement scales up to 4 digits	5 set
19	COD reactor	5 sets
20	Chemicals reagents and stabilizing chemicals	2 liters

21	Hardness meter	5 sets
22	Hardness kit box	5 sets
23	Filter paper	10 packets
24	Air Quality meter	5 sets

### **Recommended Books:**

SI	Book Name	Writer Name	Publisher Name & Edition
01	Pollution control in process industries	S. P. Mahajan	McGraw Hill Education 2017
02	Environmental Policy and Public Health: Air Pollution, Global Climate Change, and Wilderness	William N. Rom	Jossey-Bass
03	Air pollution Fundamentals of Air Pollution, Fourth Edition	Daniel A. Vallero	Elsevier Publications
04	Industrial Noise Control	Bruce Fader	John Wiley & Sons
05	পরিবেশ দূষণ (১ম ও ২য় খণ্ড)	আবদুল মালেক ভূইয়া	
06	পরিবেশ দূষণ	গৌতম পাল	
07	Sustainability Indicators	By Simon Bell, Stephen Morse	Routledge, London, 2001.
08	Down to Earth. Applying Business Principles to Environmental Management.	F. L. Reinhardt	Harvard Business School, Boston 2000, ISBN 1-57851-192-5.
09	Industrial Wastewater Treatment.	Patwardhan	2nd revised edition. PHI Learning. ISBN:8120353323; 2017
10	Industrial Wastewater Treatment, Recycling and Reuse.	Ranade & Rhandari	Butterworth-Heinemann. ISBN: 9780080999685 2014
11	Energy, Resources and Environment	Alan Reddish and John Blunden	Hodder Education, 2 <sup>nd</sup> edition
12	Exploring Environmental Issues-An integrated approach	David D. Kemp	Routledge, London

### **Website References:**

SI	Web Link	Remarks
01	<a href="http://doe.portal.gov.bd/sites/default/files/files/doe.portal.gov.bd/page/155eebe8_0092_4653_907d_421dc0890e6d/aian%20sonkolon%20fff-1-100.pdf">http://doe.portal.gov.bd/sites/default/files/files/doe.portal.gov.bd/page/155eebe8_0092_4653_907d_421dc0890e6d/aian%20sonkolon%20fff-1-100.pdf</a>	
02	<a href="http://doe.portal.gov.bd/sites/default/files/files/doe.portal.gov.bd/page/155eebe8_0092_4653_907d_421dc0890e6d/aian%20sonkolon%20fff-101-200.pdf">http://doe.portal.gov.bd/sites/default/files/files/doe.portal.gov.bd/page/155eebe8_0092_4653_907d_421dc0890e6d/aian%20sonkolon%20fff-101-200.pdf</a>	
03	<a href="http://doe.portal.gov.bd/sites/default/files/files/doe.portal.gov.bd/page/155eebe8_0092_4653_907d_421dc0890e6d/aian%20sonkolon%20fff-201-366.pdf">http://doe.portal.gov.bd/sites/default/files/files/doe.portal.gov.bd/page/155eebe8_0092_4653_907d_421dc0890e6d/aian%20sonkolon%20fff-201-366.pdf</a>	
04	Environmental Protection Agency <a href="https://www.epa.gov/laws-regulations">https://www.epa.gov/laws-regulations</a>	
05	Woodard & AMP: Industrial Waste Treatment Handbook, 2nd Edition (2006) Chapters available for free download on <a href="https://www.sciencedirect.com/book/9780750679633/industrial-waste-treatment-handbook">https://www.sciencedirect.com/book/9780750679633/industrial-waste-treatment-handbook</a>	