

**Curriculum**  
**for**  
**Post Graduate Diploma Programme in**  
**Drone Technology**

**For the State of Uttar Pradesh**

**(Duration: One Year)**  
**Semester System**



**Prepared by:**  
**Institute of Research Development & Training, Kanpur**

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### FIRST SEMESTER

1.1	Introduction to drones
1.2	Engineering materials for unmanned aerial vehicles
1.3	Drones' manufacturing processes-I
1.4	Introduction to UAV Electronics
1.5	Theory of drones
1.6	Drones' manufacturing processes-I lab

### SECOND SEMESTER

2.1	Drone's manufacturing processes-II
2.2	Drone metrology, assembly and maintenance
2.3	Computer aided 3D modeling
2.4	Project work /Flying practices

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## PREFACE

An important issue generally debated amongst the planners and academician's world over is how technical education can contribute to sustainable development of the societies struggling hard to come in the same bracket as that of the developed nations. The rapid industrialization and globalization have created an environment for free flow of information and technology through fast and efficient means. This has led to shrinking of the world, bringing people from different culture and environment together and giving rise to the concept of world turning into a global village. In India, a shift has taken place from the forgettable years of closed economy to knowledge based and open economy in the last few decades. In order to cope with the challenges of handling new technologies, materials and methods, we have to develop human resources having appropriate professional knowledge, skills and attitude. Technical education system is one of the significant components of the human resource development and has grown phenomenally during all these years. Now it is time to consolidate and infuse quality aspect through developing human resources, in the delivery system. Polytechnics play an important role in meeting the requirements of trained technical manpower for industries and field organizations. The initiatives being taken by the Department of Technical Education, UP to run new age diploma programmes as per the needs of the industry and making them NSQF compliant, are laudable.

In order to meet the requirements of future technical manpower, we will have to revamp our existing technical education system and one of the most important requirements is to develop outcome-based curricula of diploma programmes. The curricula for diploma programmes have been developed & revised by adopting time-tested and nationally acclaimed scientific method, laying emphasis on the identification of learning outcomes of diploma programme. The real success of the diploma programme depends upon its effective implementation. However best the curriculum document is designed, if that is not implemented properly, the output will not be as expected. In addition to acquisition of appropriate physical resources, the availability of motivated, competent and qualified faculty is essential for effective implementation of the curricula.

It is expected from the polytechnics to carry out job market research on a continuous basis to identify the new skill requirements, reduce or remove outdated and redundant courses, develop innovative methods of course offering and thereby infuse the much-needed dynamism in the system.

Manoj Kumar  
Director  
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**1. SALIENT FEATURES OF POST GRADUATE DIPLOMA PROGRAMME IN DRONE TECHNOLOGY**

- 1) Name of the Programme : POST GRADUATE DIPLOMA IN DRONE TECHNOLOGY
- 2) Duration of the Programme : ONE YEAR (TWO SEMESTERS)
- 3) Entry Qualification : As Prescribed by State Board of Technical Education, UP
- 4) Intake : 75 (or as prescribed by the Board)
- 5) Pattern of the Programme : Semester Pattern
- 6) NSQF Level : 8
- 7) Ratio between the theory and Practical : 1 : 1
- 8) Student Centered Activities :

A provision of 2 periods per week has been made for organizing Student Centered Activities for overall personality development of students. Such activities will comprise of co-curricular activities such as expert lectures, self-study, games, hobby classes like photography, painting, singing etc. seminars, declamation contests, educational field visits, NCC, NSS and other cultural activities, disaster management and safety etc.

- 9) Project work / Flying practice

A project work /flying practice has been included in the curriculum to enable the student get familiarize with the practices and procedures being followed in the drone industries and provide an opportunity to work on some live projects in the industry.

## **2. EMPLOYMENT OPPORTUNITIES FOR POST GRADUATE DIPLOMA HOLDERS IN DRONE TECHNOLOGY**

The following are the major employment opportunities for Post Graduate Diploma holders in drone technology:

- In manufacturing industry primarily in defense suppliers and to some extent in public sector.
- In defense sector, Railways, Hospitals, Military Engineering Services, Boards and Corporations, Construction Companies, Logistics, Telecommunication and Rural Development Agencies.
- As an entrepreneur like establishment of drone manufacturing company as startups.
- Though the Post Graduate Diploma holders in drone technology find placement in all functional areas like R&D, planning, shop floor production, quality control, inventory management but majority of them find employment in drone supplier companies and anybody, governed by directorate general of civil aviation.

### 3. LEARNING OUTCOMES OF POST GRADUATE DIPLOMA PROGRAMME IN DRONE TECHNOLOGY

After undergoing this programme, students will be able to:

1.	Understand the historical development of unmanned aerial vehicles
2.	Understand the guidelines of drone flying in India
3.	Understand the structure of unmanned aerial vehicles
4.	Understand different drone parts and their contribution for successful flight operation
5.	Understand different types of drone circuits /electronic parts
6.	Learn various electrical parts of drones
7.	Learn the criterion for the selection of various drone materials
8.	Understand the concept of surveying
9.	Learn the concepts of geographical information systems
10.	Get familiar with the concepts of basic remote sensing
11.	Explore modern and future prospects of drones in India
12.	Integrate their work with ambitious “ <b>Make in India</b> ” mission of country
13.	Make their own drones
14.	Exercise on contouring in civil engineering surveying
15.	Exercise on differential survey
16.	Understand the concepts of drone data processing systems
17.	Understand the engineering materials and their properties
18.	Learn the history of material origin for unmanned aerial vehicles
19.	Understand various issues of usage of the materials
20.	Gain knowledge of the conventional and advanced drone materials
21.	Gain expertise in drone frame material selection
22.	Select the materials for various drone accessories
23.	Understand the advantages and the uses of different plastics for UAV
24.	Gain knowledge of different manufacturing operations of drone manufacturing
25.	Understand various cutting tools and cutting tool materials
26.	Understand and practices of various conventional and advanced machining processes
27.	Learn the concepts of additive and subtractive manufacturing processes
28.	Learn the concept of digital light processing technology
29.	Understand the emerging trends in advanced manufacturing processes
30.	Workshop practice of different operations for their use in drone manufacturing

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31.	Understand the multidisciplinary theory of engineering branches in drone technology viz. mechanical engineering, electrical engineering and electronics engineering
32.	Gain practical exposure of relevant drone sciences
33.	Gain deep and real world knowledge of manufacturing limitations of drones.
34.	Understand various communication systems and their up gradation phenomenon.
35.	Learn the relevant concepts of control systems engineering
36.	Learn and exercise various measuring devices and metrological aspects in drone engineering
37.	Perform assembly practice of micro and nano drones.
38.	Learn chronological and technological development of drone sensors
39.	Understand basic rules and instruments in mechanical measurements
40.	Perform drone maintenance and understand its challenges
41.	Prepare maintenance report of UAV
42.	Learn about innovated propeller profiles and their technological benefit over the successor.
43.	Understand the concepts of 3D modeling
44.	Learning about digital citizenship and their ethics
45.	Understand texturing of prepared three dimensional models
46.	Learn about assembly modeling tools
47.	Perform manufacturing operations pertaining to UAV making
48.	Gain operational knowledge of any drone
49.	Gain expertise in thinking as to enhance innovations in the fields of drones
50.	Gain ability to improve any existing system
51.	To fly their drones with full knowledge of different legal limitations

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#### 4. DERIVING CURRICULUM AREAS FROM LEARNING OUTCOMES

The following curriculum areas/subjects have been derived from learning outcomes;

Sr. No.	Learning Outcomes	Curriculum Areas/Subjects
1.	Understand the historical development of unmanned aerial vehicles	Introduction to drones
2.	Understand the guidelines of drone flying in India	
3.	Understand the structure of unmanned aerial vehicles	
4.	Understand different drone parts and their contribution for successful flight operation	
5.	Understand different types of drone circuits /electronic parts	
6.	Learn various electrical parts of drones	
7.	Learn the criterion for the selection of various drone materials	
8.	Understand the concept of surveying	
9.	Learn the concepts of geographical information systems	
10.	Get familiar with the concepts of basic remote sensing	
11.	Explore modern and future prospects of drones in India	
12.	Integrate their work with ambitious “ <b>Make in India</b> ” mission of country	
13.	Make their own drones	
14.	Understand the engineering materials and their properties	Engineering materials for UAV
15.	Learn the history of material origin for unmanned aerial vehicles	
16.	Understand various issues of usage of the materials	
17.	Gain knowledge of the conventional and advanced drone materials	
18.	Gain expertise in drone frame material selection	
19.	Select the materials for various drone accessories	
20.	Understand the advantages and the uses of different plastics for UAV	
21.	Gain knowledge of different manufacturing operations of drone manufacturing	Drone manufacturing processes-I
22.	Understand various cutting tools and cutting tool materials	

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23.	Understand and practices of various conventional and advanced machining processes	
24.	Learn the concepts of additive and subtractive manufacturing processes	
25.	Learn the concept of digital light processing technology	
26.	Understand the emerging trends in advanced manufacturing processes	
27.	Workshop practice of different operations for their use in drone manufacturing	
28.	Understand the multidisciplinary theory of engineering branches in drone technology viz. mechanical engineering, electrical engineering and electronics engineering	Theory of drones
29.	Gain practical exposure of relevant drone sciences	Theory of drones
30.	Gain deep and real world knowledge of manufacturing limitations of drones.	Drone manufacturing processes
31.	Understand various communication systems and their up gradation phenomenon.	Introduction to UAV Electronics
32.	Learn the relevant concepts of control systems engineering	Introduction to UAV Electronics
33.	Learn and exercise various measuring devices and metrological aspects in drone engineering	
34.	Perform assembly practice of micro and nano drones.	
35.	Learn chronological and technological development of drone sensors	Drone metrology, assembly and maintenance
36.	Understand basic rules and instruments in mechanical measurements	
37.	Perform drone maintenance and understand its challenges	
38.	Prepare maintenance report of UAV	
39.	Learn about innovated propeller profiles and their technological benefit over the successor.	
40.	Understand the concepts of 3D modeling	Computer aided 3D modeling
41.	Learning about digital citizenship and their ethics	
42.	Understand texturing of prepared three dimensional models	
43.	Learn about assembly modeling tools	Computer aided 3D modeling

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44.	Perform manufacturing operations pertaining to UAV making	Project work /Flying practices
45.	Gain operational knowledge of any drone	
46.	Gain expertise in thinking as to enhance innovations in the fields of drones	
47.	Gain ability to improve any existing system	
48.	To fly their drones with full knowledge of different legal limitations	

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## **5. ABSTRACT OF CURRICULUM AREAS**

### **a) Introductory subjects**

1. Introduction to drones

### **b) Branch-specific subjects**

1. Engineering materials for unmanned aerial vehicles
2. Drones' manufacturing processes-I
3. Drones' metrology, assembly and maintenance
4. Drones' manufacturing processes-II

### **c) Industrial Training**

1. Project work / Flying practice

### **d) Applied engineering subjects**

1. Introduction to UAV Electronics
2. Theory of drones

**6. HORIZONTAL AND VERTICAL ORGANISATION OF THE SUBJECTS**

S.NO.	NAME OF SUBJECT	DISTRIBUTION OF PERIODS PER WEEK PER SEMESTER	
		I SEM	II SEM
1.	Introduction to drones	4	-
2.	Engineering materials for UAV	8	-
3.	Engineering materials for UAV lab	4	-
4.	Drones' manufacturing processes-I	6	-
5.	Introduction to UAV Electronics	6	-
6.	Introduction to UAV Electronics lab	2	-
7.	Theory of drones	6	-
8.	Theory of drones lab	2	-
9.	Drones manufacturing processes-I lab	8	-
10.	Drones' manufacturing processes-II	-	6
11.	Drones' manufacturing processes-II lab	-	6
12.	Drone metrology, assembly and maintenance	-	6
13.	Drone metrology, assembly and maintenance lab	-	2
14.	Computer aided 3D modeling	-	12
15.	Project work /flying practice	-	12
16.	Student centered activities (SCA)	2	4
<b>GRAND TOTAL OF PERIODS</b>		<b>48</b>	<b>48</b>

**7. STUDY AND EVALUATION SCHEME FOR POST GRADUATE DIPLOMA IN  
DRONE TECHNOLOGY**

**FIRST SEMESTER**

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
		L	T	P		INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
						Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
1.1	Introduction to Drones	4	-	0	5	20		20	50	2½	-	-	50	70
1.2	Engineering Materials for unmanned aerial vehicles	8	0	4	5	20	10	30	50	2½	20	3	70	100
1.3	Drones Manufacturing Processes-I	6	0	0	4	20	-	20	50	2½	-	-	50	70
1.4	Introduction to UAV electronics	6	0	2	4	20	10	30	50	2½	20	3	70	100
1.5	Theory of drones	6	0	2	5	20	10	30	50	2½	20	3	70	100
1.6	Drones' Manufacturing Processes-I Lab	-	-	8	2	-	20	20	-	-	60	4	60	80
#Student Centered Activities (SCA)		-	-	2	1	-	30	30	-	-	-	-	-	30
<b>Total</b>		<b>30</b>	<b>0</b>	<b>18</b>	<b>26</b>	<b>100</b>	<b>80</b>	<b>180</b>	<b>250</b>		<b>120</b>	<b>-</b>	<b>370</b>	<b>550</b>

**SECOND SEMESTER**

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
		L	T	P		INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
						Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
2.1	Drones' manufacturing processes-II	6	0	6	4	20	10	30	50	2½	20	3	70	100
2.2	Drone metrology, assembly and maintenance.	6	0	2	5	20	20	40	50	2½	40	3	90	130
2.3	Computer aided 3D Modeling	-	-	12	5	-	40	40	-	-	80	3	80	120
2.5	Project work /Flying practice	-	-	12	5	-	40	40	-	-	80	4	80	120
#Student Centered Activities (SCA)		-	-	4	1	-	30	30	-	-	-	-	-	30
<b>Total</b>		<b>12</b>	<b>0</b>	<b>36</b>	<b>20</b>	<b>40</b>	<b>140</b>	<b>180</b>	<b>100</b>	<b>-</b>	<b>220</b>	<b>-</b>	<b>320</b>	<b>500</b>

#Student Centered Activities will comprise of co-curricular activities like extension lectures, Self study, games, hobby clubs e.g. photography etc., seminars, declamation contests, Educational field visits, N.C.C., NSS, Cultural Activities, disaster management and safety Etc.



## **8. GUIDELINES (FOR ASSESSMENT OF STUDENT CENTERED ACTIVITIES AND INTERNAL ASSESSMENT)**

It has been discussed and decided that the maximum marks for SCA should be 30 as it involves a lot of subjectivity in the evaluation. The marks may be distributed as follows:

- i. 10 Marks for general behavior and discipline.  
(By HODs in consultation with all the teachers of the department)
- ii. 5 Marks for attendance as per following:  
(By HODs in consultation with all the teachers of the department)
  - a) 75 - 80% 2 Marks
  - b) 80 - 85% 4 Marks
  - c) Above 85% 5 Marks
- iii. 15 Marks maximum for Sports/NCC/Cultural/Co-curricular/ NSS activities as per Following:  
(By In-charge Sports/NCC/Cultural/Co-curricular/NSS)
  - a) 15 - State/National Level participation
  - b) 10 - Participation in two of above activities
  - c) 5 - Inter-Polytechnic level participation

Note: There should be no marks for attendance in the internal seasonal examination of different subjects.

## 1.1 INTRODUCTION TO DRONES

L	T	P
4	0	0

**RATIONALE** – The objective of this course is to impart introductory knowledge of Drones, their components and introduction to drone materials.

### LEARNING OUTCOMES-

- Understand the historical development of unmanned aerial vehicles
- Understand the guidelines of drone flying in India
- Understand the structure of unmanned aerial vehicles
- Understand different drone parts and their contribution for successful flight operation
- Understand different types of drone circuits /electronic parts
- Learn various electrical parts of drones
- Learn the criterion for the selection of various drone materials
- Understand the concept of surveying
- Learn the concepts of geographical information systems
- Get familiar with the concepts of basic remote sensing
- Explore modern and future prospects of drones in India
- Integrate their work with ambitious “Make in India” mission of country
- Make their own drones

### DETAILED CONTENTS

1. Introduction to drones and their applications: - Definition of drones, history of drones, India and drones, tinkering and drones. (10 periods)
2. Key features of drone regulations:- Notification of final regulations for civil use, operational and procedural requirements, no drone zones, operations through digital platform, enforcement actions, relevant sections of aircraft act-1934 (10 periods)
3. Structural classification of drones: - fixed wing structure, lighter than air systems, rotary wings aircraft, and applications of drones. (10 periods)
4. Components of drones:-classifications of drone structures and their suitability, applications and uses of drone frame materials, classifications and applicability of propeller motors, drone propeller materials, design parameters for propellers, composition and structuring of electronic speed controller, flight control board, characteristics of FCB and their structure. (10 periods)
5. Criterion for material selection for drone design:-description of all components (analytical portion to be skipped). (04 periods)
6. Surveying, GIS and remote sensing:-surveying and survey equipments, introduction to remote sensing, principles of energy interaction in atmosphere and earth surface, features, digital image processing, GPS, GIS, key components of GIS, functions of GIS, spatial and geo-spatial analysis, integration of GIS and remote sensing with reference to drone technology, introduction to data processing using remote sensing and GIS. (12 periods)

**INSTRUCTIONAL STRATEGY:-**Students should be encouraged for learning basic concepts of unmanned aerial vehicles with key emphasis on drones.

**MEANS OF ASSESSMENT:**

-

- Assignments and quiz/class tests, mid-semester and end-semester written tests
- Actual practical work, exercises and viva-voce
- Presentation and viva-voce

**RECOMMENDED BOOKS / OTHER SOURCES:-**

1. [www.asteria.co.in](http://www.asteria.co.in)
2. [www.kisspng.com](http://www.kisspng.com)
3. [www.droneaviation.com](http://www.droneaviation.com)
4. [www.dji.com](http://www.dji.com)
5. [www.aerosociety.com](http://www.aerosociety.com)

**SUGGESTED DISTRIBUTION OF MARKS**

<b>TOPIC NO.</b>	<b>ALLOTTED PERIODS</b>	<b>PERCENTAGE MARKS ALLOTTED</b>
<b>1.</b>	10	18
<b>2.</b>	10	18
<b>3.</b>	10	18
<b>4.</b>	10	18
<b>5.</b>	04	08
<b>6.</b>	12	20

## 1.2 ENGINEERING MATERIALS FOR UNMANNED AERIAL VEHICLES

L	T	P
8	0	4

**RATIONALE**-The objective of this course is to train the students about conventional & advanced engineering materials specially pertaining to drones.

### LEARNING OUTCOMES-

- Understand the engineering materials and their properties
- Learn the history of material origin for unmanned aerial vehicles
- Understand various issues of usage of the materials
- Gain knowledge of the conventional and advanced drone materials
- Gain expertise in drone frame material selection
- Select the materials for various drone accessories
- Understand the advantages and the uses of different plastics for UAV

### DETAILED CONTENTS

1. Introduction, history of material origin, scope of material science, overview of various engineering materials and their applications, classification of materials and their mechanical, thermal, chemical and electrical properties, present and future needs of materials, various issues of material usage-economical, environmental and social. (20 periods)
2. Materials
  - 2.1 Plastics-classification, applications and uses of thermoplastic.
  - 2.2 Composites-classification and importance of composites, phases of composite materials-primary and secondary phase, introduction to fiber, particle, flake, laminar and filled composites. Purpose and role of matrix material, the reinforcing phase, functional requirements, functional requirements of reinforcement and matrix. Open mold processes, closed mold process, filament winding, pultrusion process, other PMC shaping process. Combining matrix and reinforcement molding compounds, hand lay-up method, spray up method, vacuum bag molding, pressure bag molding, and thermal expansion molding and auto clave molding curing. Fabrication of ceramic matrix composites. Interface in ceramic matrix composites.
  - 2.3 Material selection for UAV frame: factors to be considered for material selection-manufacture ability, cost, strength, weight, manufacturing cost, availability, physical properties, mechanical properties.
  - 2.4 Ceramics-Adhesives – Classification, properties and applications, Smart materials - properties and applications. (30 periods)
3. Advanced material-Basic material characteristics, relative ranking of characteristic material properties, top materials used in drones-carbon fiber, carbon reinforced composites, thermoplastics, aluminum and its alloys, titanium alloys. (20 periods)
4. Drone frame materials-properties of balsa wood, PLA/ABS, aluminum and carbon fibers, advantages and limitations of above materials and idea of cost estimation. (20 periods)
5. Materials for propellers and guide materials-properties, uses, merits and demerits of polycarbonates, nylon carbon composites and thermoplastics. (22 periods)

### LIST OF PRACTICALS:-

1. To study and visual inspection of various materials for drone frames, propellers and guides.
2. To study the micro structures of different materials used in drones.
3. To determine the strength of various materials used in drones.

4. To study the various properties of plastics/ceramics.
5. To study the various properties of composite materials.
6. To study the different heat treatment processes.
7. Practices on various drone assembly materials.

**INSTRUCTIONAL STRATEGY:-**Teacher should merely focus on the important materials, used in manufacturing of drones.

**MEANS OF ASSESSMENT:-**

- Assignments and quiz/class tests, mid-semester and end-semester written tests
- Actual practical work, exercises and viva-voce
- Presentation and viva-voce

**RECOMMENDED BOOKS / OTHER SOURCES:-**

1. Text book of material science by R.K. Rajput, Katson Publications.
2. Material Science of Hazra Chaudhary.
3. Material Science & Engineering by R. Raghvan, PHI.
4. <http://swayam.gov.in>

**SUGGESTED DISTRIBUTION OF MARKS**

TOPIC NO.	ALLOTTED PERIODS	PERCENTAGE MARKS ALLOTTED
1.	20	18
2.	30	26
3.	20	18
4.	20	18
5.	22	20

### 1.3 DRONES' MANUFACTURING PROCESSES-I

L	T	P
6	0	0

**RATIONALE** – The objective of this subject to transmit basic knowledge of various manufacturing process, equipment's and tooling.

#### **LEARNING OUTCOMES-**

- Gain deep and real world knowledge of manufacturing limitations of drones.
- Perform turning, step turning, taper turning, threading and knurling operation on lathe machine.
- Explain uses of lathe accessories and different types of lathes.
- Perform drilling, reaming, counter boring, counter sinking and tapping operations on drilling machine.
- Use milling machine accessories and attachments.
- Perform milling machine operations on vertical and horizontal milling machine.
- Understand theory, raw materials and tools/equipment's in carpentry shop, painting and polishing shop, electrical shop and smithy shop.

#### **DETAILED CONTENTS**

##### 1. Drone structure making:-

Name and use of raw materials used in carpentry shop: wood & alternative materials, Names, uses, care and maintenance of hand tools such as different types of Saws, C-Clamp, Chisels, Mallets, Carpenter's vices, marking gauges, Try-squares, Rulers and other commonly used tools and materials used in Carpentry shop by segregating as cutting tools, supporting tools, holding tools, measuring tools etc., Different types of Timbers, their properties, uses & defects. Seasoning of wood. (20 periods)

2. Painting and polishing shop: -Introduction of paints, varnishes, Reason for surface preparation, Advantages of Painting, other method of surface coating ie. Electro-plating etc. (15 periods)

3. Electrical shop:-Study, demonstration and identification of common electrical materials with standard ratings and specifications such as wires, cables, switches, fuses, cleats, clamps and allied items, tools and accessories (15 periods)

4. Metal cutting:- principle of lathe operations like turning, drilling, shaping, threading, milling, grinding, introduction to cutting fluids and lubricants, brief introduction to single point cutting tools and multi point cutting tools. (20 periods)

5. Metal joining: - introduction, types and importance of welding as compared to other material joining processes, welding joints and welding positions, materials to be welded. (14 periods)

**INSTRUCTIONAL STRATEGY:-**Instructors should focus on manufacturing of drone components and their teaching methodology should be in accordance.

**MEANS OF ASSESSMENT:-**

-Actual practical work, exercises and viva-voce

**RECOMMENDED BOOKS / OTHER SOURCES:-**

1. Workshop technology by S.K.Hazra.
2. Manual of workshop practice by K.Venkat reddy.
3. Workshop technology by B.S.Raghuvanshi,Dhanpatrai and company limited.
4. Workshop technology by H.S.Bawa.TMH publishers.

**SUGGESTED DISTRIBUTION OF MARKS**

<b>TOPIC NO.</b>	<b>ALLOTTED PERIODS</b>	<b>PERCENTAGE MARKS ALLOTTED</b>
<b>1.</b>	20	25
<b>2.</b>	15	18
<b>3.</b>	15	18
<b>4.</b>	20	25
<b>5.</b>	14	14

## 1.4 INTRODUCTION TO UAV ELECTRONICS

L	T	P
6	0	4

**RATIONALE-** The objective of this subject is to impart fundamental knowledge and skills regarding basic electrical and electronics engineering, which students will come across in their professional life while designing circuits for their own Drones. This course will provide the student to understand the basic concept and principles of batteries, Motors, electronics and electrical components and devices etc. The students should understand the advantages and limitations of various communication devices, sensors, microcontrollers and controllers used in UAVs. Thus the diploma-holder in Drone Technology shall find employment in areas of R and D, manufacturing, servicing and maintenance of drones in various UAVs industries.

### LEARNING OUTCOMES-

After undergoing the subject, the student will be able to:

- Identify the battery to be used for UAV application.
- Understand working of motor that can be used in UAV.
- Explain the basic concept of communication system.
- Find out best communication device for given project.
- Understand different types of sensors used in drone technology.
- Classify different microcontrollers and flight controllers.
- Identify different types of ports and connectors.

### DETAILED CONTENTS

- 1. Battery and its management (10 periods)**  
Introduction of Battery, Description of Li-Po Battery, Charging / Discharging of Battery. Back up, Ratings, Shelf Life, Maintenance and safety of Battery. Selection criteria of Battery for Drone application.
- 2. Motors (16 periods)**  
Difference between AC and DC motors and stepper motor, Brushed and Brushless motors, brief idea of motor capabilities for a drone build. Selection criterion of motor for drone application. Working and application of BLDC motor.
- 3. Sensors (16 periods)**  
Wi fi devices, RADAR and range finder, GPS receiver, Gyro sensor, Speed and Distance sensor, Image sensor, TOF sensor, Chemical sensor. Cameras in drones and selection criteria of camera for different range. Barometers, Accelerometer, Magnetometer, remote control for drone.
- 4. Radio Control System (20 periods)**  
Introduction of radio control system, Controllers, Transmitter and Receiver, Flight Controllers, Electronic Speed Controller, SIMONK & BLHelifirmware software, Battery Eliminator Circuit, Universal Battery Eliminator Circuit, OPTO Coupler.
- 5. Connections and Interfaces of Devices in Drone (12 periods)**  
Brief introduction of RS232, RS422, RS485, UART ports. Different types of connectors and their specifications. Microcontroller interfacing techniques.



## 6. Introduction to Drone Programming (10 Periods)

Introduction to programming language used in drone : C and Python. Installation of cards. Auto Pilot software i.e. Ardupilot, Openpilot.

### LIST OF PRACTICALS

1. To record and recognize different battery specifications.
2. To identify DC motor useful for UAV system.
3. To demonstrate speed control of BLDC Motor using PWM technique.
4. To measure the frequency and level of RF signals using of spectrum analyzer.
5. To configure, test and perform communication of FCB with motor, GPS, ESC and sensors.
6. To identify different features of controls of HD and thermal image of camera used in drone.
7. To identify of different types of SMD IC packages.
8. To identify different types of ports and connectors.

**INSTRUCTIONAL STRATEGY:** -Teacher should merely focus on the important electronics components and devices used in manufacturing of drones.

### MEANS OF ASSESSMENT: -

- Assignments and quiz/class tests, mid-semester and end-semester written tests.
- Actual practical work, exercises and viva-voce
- Presentation and viva-voce

### RECOMMENDED BOOKS / OTHER SOURCES:-

1. Robert L. Boylestad / Louis Nashelsky“Electronic Devices and Circuit Theory”, Latest Edition, Pearson Education.
2. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill.
3. J.B. Gupta, Basic Electrical Engineering, Kataria& Sons.
4. H S Kalsi, “Electronic Instrumentation”, Latest Edition, TMH Publication.
5. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost (Green Energy and Technology) by Gianfranco Pistoia, Boryann Liaw , Springer.
6. An Introduction to Analog and Digital Communication by Simon Haykin, Wiley Student Edition.
7. Electronics Communication System by Kennedy, Tata McGraw Hill Education Pvt Ltd, New Delhi.
8. Wireless Communications | Second Edition | By Pearson: Principles and Practice.
9. Programmable Microcontrollers With Applications ( Cem Unsalan, H. Deniz Gurhan)
10. Drone Technology in Architecture, Engineering and Construction (, Tal Daniel).

### SUGGESTED DISTRIBUTION OF MARKS

TOPIC NO.	ALLOTTED PERIODS	PERCENTAGE MARKS ALLOTTED
1.	10	10
2.	16	10
3.	16	20
4.	20	20
5.	12	20
6.	10	20
<b>Total</b>	<b>84</b>	<b>100</b>

## 1.5 THEORY OF DRONES

L	T	P
6	0	2

**RATIONALE-** The objective of this subject is to teach the students fundamental mechanical engineering concepts, applied to drone engineering.

**LEARNING OUTCOMES-**After studying this course, the students will be able to;

- Identify and select different drones' mechanical parts, aerodynamics of wings, propellers.
- Gain practical exposure of relevant drone sciences.

### DETAILED CONTENTS

1. Drone Mechanics:-concepts of engineering mechanics, definition of mechanics, statics, dynamics, applications of engineering mechanics in practical fields. Free body diagrams types of loads, Principles and concept of moments and its applications, Methods for finding resultant of a force system, equilibrium of coplanar force systems. (20 periods)
2. Center of gravity:-concepts, definition of centroid of plane figures and centre of gravity of symmetrical solid bodies, determination of centroid of plane and composite lamina using first principle, centroid of areas with removed portions .CG of solid bodies like cone, cylinder, hemisphere and sphere, bodies with removed portions. (16 periods)
3. Force analysis in drones: - force analysis in drones, forces and force systems during drone operations, aerodynamics of drones-dynamics of aerial systems, forces of flight, principle axes and rotation of aerial systems. (14 periods)
4. Stability and control of drones:-stability and control of drones, force balancing of rotating masses. (6 periods)
5. Flywheels:-Principles and applications of flywheels. (10 periods)
6. Dynamics of machines:-static and dynamic force analysis, gyroscopic action in machines, gyroscopic motions and their variations, concept of gyroscopic couple. (18 periods)

### LIST OF PRACTICALS

1. To verify polygon law of forces using Gravesend apparatus.
2. To findout center of gravity of regular lamina.
3. To find out centre of gravity of irregular lamina.
4. To balance the rotating masses by using single counter mass.
5. To observe gyroscopic motions qualitatively.
6. To study the operation and working of rim type flywheel.
7. To study and sketch various frame structure viz. quadcopter frame (plus shape, cross shape and H-shape),hexacopter frame (hexa+ and hexa S).

**INSTRUCTIONAL STRATEGY**Teacher should merely focus on the important materials, used in manufacturing of drones.

### MEANS OF ASSESSMENT

- Assignments and quiz/class tests, mid-semester and end-semester written tests
- Actual practical work, exercises and viva-voce
- Presentation and viva-voce

**RECOMMENDED BOOKS / OTHER SOURCES:-**

1. A textbook of applied mechanics by S.Ramamurtham.
2. A textbook of engineering mechanics by R.S.Khurmi.
3. A textbook of applied mechanics by R.K.Rajput.
4. Theory of machines by D.R.Malhotra.
5. Theory of machines by V.P.Singh.
6. Theory of machines by Dr.Jagdish Lal.

**SUGGESTED DISTRIBUTION OF MARKS**

<b>TOPIC NO.</b>	<b>ALLOTTED PERIODS</b>	<b>PERCENTAGE MARKS ALLOTTED</b>
<b>1.</b>	20	25
<b>2.</b>	16	20
<b>3.</b>	14	18
<b>4.</b>	6	10
<b>5.</b>	10	12
<b>6.</b>	18	15

## 1.6 DRONES' MANUFACTURING PROCESSES-I LAB

L	T	P
0	0	8

### DETAILED CONTENTS

#### 1. DRONE STRUCTURING PRACTICE

- To practice Marking, sawing, planning and chiseling.
- To prepare Half Lap Joint (cross, L or T – any one)
- To prepare mortise and tenon joint.

#### 2. PAINTING AND POLISHING PRACTICE

- To prepare metal surface for painting, apply primer and paint the same.
- To prepare a metal surface for spray painting, first spray primer and Paint the same by spray painting gun and compressor system.

#### 3. ELECTRICAL COMPONENTS' PRACTICE

- To install battery and connecting two or three batteries in Series and parallel.
- To Charge a battery and testing with hydrometer and cell Tester

#### 4. METAL CUTTING PRACTICE

- To practice plain, turning, knurling, drilling, boring, reaming and tapping.
- To study and sketch of planning/shaping machine and to plane a rectangle of cast iron.
- To practice boring with the help of boring bar.
- To study the different grinding and abrasive machining process.

#### 5. METAL JOINING PRACTICE

- To prepare T-Joint using arc welding.
- To prepare lap joint using gas welding.
- To practice spot welding / seam welding.

## 2.1 DRONES' MANUFACTURING PROCESSES-II

L	T	P
6	0	6

**RATIONALE**-The objective of this subject is to instruct the students regarding advanced manufacturing process, required for drones 'components fabrication.

**LEARNING OUTCOMES**-After studying this subject, student will be able to;

- Gain knowledge of different manufacturing operations of drone manufacturing.
- Understand various advanced machining operations.
- Learn the concepts of additive and subtractive manufacturing processes.
- Learn the concept of digital light processing technology.
- Understand the emerging trends in advanced manufacturing processes.
- Workshop practice of different operations for their use in drone manufacturing.

### DETAILED CONTENTS

1. Introduction to advanced machining processes, sources and forms of energy utilized, classification of advanced machining and advanced welding processes. (15 periods)
2. Modern machining processes:-  
Mechanical Process - Ultrasonic machining (USM): Introduction, principle, Process, advantages and limitations, applications, Electro Chemical Processes - Electro chemical machining (ECM), Electrical Discharge Machining (EDM) - Introduction, basic EDM circuit, Principle, metal removing rate, dielectric fluid, applications, Laser beam machining (LBM) – Introduction, machining process and applications, Plasma arc machining (PAM) and welding Introduction, principle process and Applications. (20 periods)
3. Additive manufacturing processes-basic principles, parts of AM used for generic AM processes, comparison of AM with conventional manufacturing processes. Principle of FDM printing, Introduction, principle and applications of selective laser sintering, fused deposition modeling, stereo lithography, laminated object manufacturing, 3D printing. Manufacturing of UAV wings: vacuum bagging method, manufacturing of skin mold of mini UAV wings-manufacturing processes for male models of the wings, manufacturing of upper and lowers wings skin female molds, manufacturing the components of the wings. (15 periods)
4. Introduction to CNC, setting up the jobs, defining the operations, creating geometry, specifying the tools, machining parameters and types of machining, back-plotting and verification of operation, post processing-converting the generated tool path in NC code depending on the system, setting up the parameters relating to communication like transfer of programmes to CNC machines, transfer of drawing data from any CAD software to CNC, MIC and generation of programme G and M codes. (10 periods)
5. Identification of extrusion additive manufacturing technology viz. fused filament and continuous filament fabrication. (08 periods)
6. Additive manufacturing techniques-. AM techniques- VAT photo polymerization, material extrusion, binder jetting, powder bed fusion, direct energy deposition and sheet lamination. selective laser sintering and direct metal metal selective laser sintering. (16 periods)

## LIST OF PRACTICALS

1. To study different sources of energies, used in advanced machining operations.
2. To study various parameters of material removal rate in abrasive jet machining.
3. To study various parameters of material removal rate in ultrasonic machining.
4. To study the process of rapid prototyping and tooling.
5. To prepare the wings of an unmanned aerial vehicles using 3D printing process.
6. To study the operational procedure of subtractive manufacturing operations.
7. Preparation of propeller blades profile by using selective laser sintering (SLS).
8. To make motor mount using FDM / 3D printer.
9. To create circular/ rectangular/ square/ oval profile on carbon reinforced composite.

**INSTRUCTIONAL STRATEGY**-Students should be encouraged for learning basic concepts of unmanned aerial vehicles with key emphasis on drones.

## MEANS OF ASSESSMENT

- Assignments and quiz/class tests, mid-semester and end-semester written tests.
- Actual practical work, exercises and viva-voce.
- Presentation and viva-voce.

## RECOMMENDED BOOKS / OTHER SOURCES

1. Manufacturing science by ghosh A and Mallik A K.
2. Introduction to manufacturing processes by Schey J.
3. Manufacturing processes by Dhar.
4. Manufacturing engineering by Singh K Hiraniya.

## SUGGESTED DISTRIBUTION OF MARKS

TOPIC NO.	ALLOTTED PERIODS	PERCENTAGE MARKS ALLOTTED
1.	15	18
2.	20	20
3.	15	18
4.	10	10
5.	08	06
6.	16	18

## 2.2 DRONE METROLOGY, ASSEMBLY AND MAINTENANCE

L	T	P
6	0	2

**RATIONALE-** The objective of this subject is to train the students pertaining various measurements and their processes, assembly practices and execute different maintenances.

**LEARNING OUTCOMES-**after studying this course, the students will be able to;

- Learn and exercise various measuring devices and metrological aspects in drone engineering
- Perform assembly practice of micro and nano drones.
- Learn chronological and technological development of drone sensors
- Understand basic rules and instruments in mechanical measurements
- Perform drone maintenance and understand its challenges
- Prepare maintenance report of UAV

### DETAILED CONTENTS

1. Introduction and scope of metrology in drone technology:- basic concepts of metrology, classifications of measurements, need of measurements in drone technology, types of measuring instruments, their accuracy and precision parameters. (15 periods)
2. Development and need of drone sensors:-micro electro mechanical systems (MEMS) based sensors like accelerometer, barometer, gyro sensors and magneto meter, stabilization of drones using above sensors. (18 periods)
3. Special purpose drone sensors:-need and application of distance sensors, brief introduction to light-pulse distance sensing (laser), radio detection and ranging, sonar-pulse distance sensing (ultrasonic), time of flight (TOF) sensors, thermal and chemical sensors. (18 periods)
4. Assembly of drones:-concept of interchangeability, principles of gauging and their applicability in drone assembly, parameters and profile measurements of standard propellers, limits, fits and tolerances. Concepts of drones' assembly using three dimensional modeling. (18 periods)
5. Drone maintenance:-need and scope of drone maintenance, types of maintenance, routine drone maintenance and its checklist-introduction, recording basic details, structural inspections, battery check, software/firmware (description not required).Finishing up-forward maintenance report, maintenance challenges in small UAVs. (15 periods)

### LIST OF PRACTICALS

1. Internal and external measurements using vernier calipers and micrometer.
2. Measurements of linear dimensions with height gauge and depth gauge.
3. Measurements of flatness, concentricity with dial indicator.
4. Study of necessary and sufficient types of sensors for a specific purpose unmanned aerial vehicle.
5. Measurements of propellers' profile using profile projector.
6. Study of typical maintenance task of an unmanned aerial vehicle.

**INSTRUCTIONAL STRATEGY:-**Students should be encouraged for learning basic concepts of unmanned aerial vehicles with key emphasis on drones.

**MEANS OF ASSESSMENT**

- Assignments and quiz/class tests, mid-semester and end-semester written tests
- Actual practical work, exercises and viva-voce
- Presentation and viva-voce

**RECOMMENDED BOOKS / OTHER SOURCES**

**SUGGESTED DISTRIBUTION OF MARKS**

TOPIC NO	TIME ALLOTTED	MARKS ALLOCATION
1	15	17
2	18	22
3	18	22
4	18	22
5	15	17



## 2.3 COMPUTER AIDED 3D MODELING

L	T	P
0	0	12

**RATIONALE** – The objective of this course is to develop designing/modeling skills in the students by which they can design/model different shapes and make 3D models of the objects used in drones.

### LEARNING OUTCOMES –

- Understand the concepts of 3D modeling.
- Learning about digital citizenship and their ethics.
- Understand texturing of prepared three-dimensional models.
- Learn about assembly modeling tools.

### DETAILED CONTENTS

1. Introduction and historical development of 3D modeling:-definition of three-dimensional modeling, enhancement of animation with the aid of three dimensional modeling, applications of three dimensional modeling ,key terms used in three dimensional modeling, advantages and challenges in three dimensional modeling.
2. Tools of the trade:-history of operating systems, distinct functions of hardware and software, types of memory.
3. Digital citizenship and ethics:-importance of responsible digital citizenship, copyright dynamics and its application in 3D modeling, role of emerging technology in 3d modeling.
4. Creating 3D environment:-understanding the appropriate uses of 3D components of UAV and related digital tools, use of proper digital tools, contrasts among various 3D modeling techniques.
5. Visual elements:-process of visualization applicable to 3D modeling, intensity and applying color theories, visual simulation and uses.
6. Texturing:-technical concepts behind texturing, basic materials and textures, applying textures to 3D models and environments.
7. Assembly modeling tools:-Introduction to assembly modeling and approaches-top down and bottom-up approach, applying standard mates-coincident, parallel, perpendicular, tangent, concentric, lock, distance, angle, applying advanced mates-symmetric, width, path mate, linear/linear coupler, limit mate. Manipulating components, collision detection, physical dynamics, dynamic clearance, creating explode views of drone components assembly.

### LIST OF PRACTICALS

1. To practice 2D and 3D commands in Auto CAD.
2. To develop propeller blade profile using CAD software.
3. To develop wings profile using CAD software.
4. Creation of simple surfaces using revolved surface, ruled surface, 3D surface command.
5. To design solid primitives by using region extrude and revolved features.
6. Creating explode views of drone components assembly using CAD software.

**INSTRUCTIONAL STRATEGY:**-Students should be encouraged for learning basic concepts of unmanned aerial vehicles with key emphasis on drones.

**MEANS OF ASSESSMENT**

- Assignments and quiz/class tests, mid-semester and end-semester written tests
- Actual practical work, exercises and viva-voce
- Presentation and viva-voce

**RECOMMENDED BOOKS / OTHER SOURCES**

1. Engineering Drawing with AutoCAD 2000 by T. Jeyapooran; Vikas Publishing House, Delhi.
2. AutoCAD for Engineering Drawing Made Easy by P. NageswaraRao; Tata McGraw Hill, New Delhi.
3. AutoCAD 2000 for you by UmeshShettigar and Abdul Khader; Janatha Publishers, Udupi.
4. Auto CAD 2000 by Ajit Singh, TMH, New Delhi.
5. Designing with Pro Engineer, Sham Tickoo by Dream Tech Publications, New

## 2.4 PROJECT WORK /FLYING PRACTICE

L	T	P
0	0	12

**RATIONALE**–The aim of this subject is to create innovative and practical thinking in the students so as to make them enable to fabricate, assemble and fly their drones within the legal limitations.

### LEARNING OUTCOMES –

1. Perform manufacturing operations pertaining to UAV making.
2. Gain operational knowledge of any drone.
3. Gain expertise in thinking as to enhance innovations in the fields of drones.
4. To fly their drones with full knowledge of different legal limitations.

### DETAILED CONTENTS

#### LIST OF PRACTICALS

The projects given to the students should be such, for which someone is waiting for a solution. Some of projects activities are given below;

1. Projects connected with repair and maintenance.
2. Projects related to estimating and costing.
3. Projects on optimization of performance parameters of drones.
4. Projects related to increase in efficiency and effectiveness of a drone task.
5. Projects related to assembly of drones.
6. Projects related to fabrication of drones.
7. Projects related to improvements of an existing system.

Each project will be treated as complete provided the validation of performance parameters from flying practices.

#### INSTRUCTIONAL STRATEGY

Students should be encouraged for learning basic concepts of unmanned aerial vehicles with key emphasis on drones.

#### MEANS OF ASSESSMENT

- Assignments and quiz/class tests, mid-semester and end-semester written tests
- Actual practical work, exercises and viva-voce
- Presentation and viva-voce

#### RECOMMENDED BOOKS / OTHER SOURCES

- [www.dronelife.com](http://www.dronelife.com)
- [www.rotordronepro.com](http://www.rotordronepro.com)
- [www.uavcoach.com](http://www.uavcoach.com)
- [www.dronestagr.am](http://www.dronestagr.am)

## 10. RESOURCE REQUIREMENT

### Physical Resources

#### *Space Requirement:*

Norms and standards laid down by All India Council for Technical Education (AICTE) may be followed to work out space requirement in respect of class rooms, tutorial rooms, drawing halls, laboratories, space required for faculty, student amenities and residential area for staff and students.

S.No.	Particulars	Qty.
1.	Basic Equipments	
1.1	3D printer	01
1.2	filament for 3D printer (ABS)	01
1.3	soldering iron	as per requirement
1.4	soldering wire	as per requirement
1.5	hot glue gun	as per requirement
1.6	wire cutters	as per requirement
1.7	electrical tape	as per requirement
1.8	heat shrinks	as per requirement
1.9	multimeter	02
1.10	screw drivers	02 sets
2.	Drone structuring tools	
2.1	hand tools	02 sets
2.2	marking knife	02 sets
2.3	marking gauge	02
2.4	mechanical pencil	02 sets
2.5	combination squares	2
2.6	chisels	02 sets
2.7	hand held planer	02
2.8	hand saw	02
2.9	hammer	02
3.	Power tools	
3.1	circular saw	02
3.2	power drill	02
3.3	Jig saw	02
3.4	random orbit sander	02
3.5	router	02
3.6	Thrust measuring stand	02
3.7	magnetic propeller balancer	02
3.8	laser tachometer	02
3.9	anemometer	02
3.10	433 MHz. telemetry	02
4.	Metal working tools	
4.1	benchvice	04
4.2	C-clamps / G-clamps	02 each
4.3	hacksaw	02

4.4	various files	02 set
4.5	drill and drill bits	02
4.6	threading tap	02
4.7	pop rivets	02 set
4.8	band saw	02
5.	Components	
5.1	main frame	as per requirements
5.2	Li-Po battery	as per requirements
5.3	power distribution board	as per requirements
5.4	electronic speed control	as per requirements
5.5	brushless DC motor	as per requirements
5.6	propellers	as per requirements
5.7	flight controller	as per requirements
5.8	transmitter and receiver	as per requirements
5.9	battery charger	01
5.10	battery tester	01
5.11	sensors- inertia measurements, ultrasonic, proximity sensors	02 each

### **Furniture Requirement**

1. Norms and standards laid down by AICTE be followed for working out furniture requirement for this course.
2. Furniture for laboratories/Computer Centre 15 lacs

### **Human Resources**

3. Weekly work schedule, annual work schedule, student teacher ratio for various group and class size, staffing pattern, work load norms, qualifications, experience and job description of teaching staff workshop staff and other administrative and supporting staff be worked out as per norms and standards laid down by the AICTE. The website [www.aicte.ernet.in](http://www.aicte.ernet.in) may be referred for downloading current norms and standards pertaining to technician courses.

## **EVALUATION STRATEGY**

### **INTRODUCTION**

Evaluation plays an important role in the teaching-learning process. The major objective of any teaching-learning endeavour is to ensure the quality of the product which can be accessed through learner's evaluation.

The purpose of student evaluation is to determine the extent to which the general and the specific objectives of curriculum have been achieved. Student evaluation is also important from the point of view of ascertaining the quality of instructional processes and to get feedback for curriculum improvement. It helps the teachers in determining the level of appropriateness of teaching experiences provided to learners to meet their individual and professional needs. Evaluation also helps in diagnosing learning difficulties of the students. Evaluation is of two types: Formative and Summative (Internal and External Evaluation)

### **Formative Evaluation**

It is an on-going evaluation process. Its purpose is to provide continuous and comprehensive feedback to students and teachers concerning teaching-learning process. It provides corrective steps to be taken to account for curricular as well as co-curricular aspects.

### **Summative Evaluation**

It is carried out at the end of a unit of instruction like topic, subject, semester or year. The main purpose of summative evaluation is to measure achievement for assigning course grades, certification of students and ascertaining accountability of instructional process. The student evaluation has to be done in a comprehensive and systematic manner since any mistake or lacuna is likely to affect the future of students.

In the present educational scenario in India, where summative evaluation plays an important role in educational process, there is a need to improve the standard of summative evaluation with a view to bring validity and reliability in the end-term examination system for achieving objectivity and efficiency in evaluation.

## **11.2 STUDENTS' EVALUATION AREAS**

The student evaluation is carried out for the following areas:

- Theory
- Practical Work (Laboratory, Workshop, Field Exercises)
- Project Work

### **A. Theory**

Evaluation in theory aims at assessing students' understanding of concepts, principles and procedures related to a course/subject, and their ability to apply learnt principles and solve problems. The formative evaluation for theory subjects may be caused through sessional /class-tests, home-assignments, tutorial-work, seminars, and group discussions etc. For end-term evaluation of theory, the question paper may comprise of three sections.

#### **Section-I**

It should contain objective type items e.g., multiple choice, matching and completion type. Total weightage to Section-I should be of the order of 20 percent of the total marks and no choice should be given in this section. The objective type items should be used to evaluate students' performance in knowledge, comprehension and at the most application domains only.

#### **Section-II**

It should contain short answer/completion items. The weightage to this section should be of the order of 40 percent of the total marks. Again, no choice should be given in section-II

#### **Section-III**

It may contain two to three essay type questions. Total weightage to this section should be of the order of 40 percent of the total marks. Some built-in, internal choice

of about 50 percent of the questions set, can be given in this section

**Table II: Suggested Weightage to be given to different ability levels**

<b>Abilities</b>	<b>Weightage to be assigned</b>
Knowledge	10-30 percent
Comprehension	40-60 percent
Application	20-30 percent
Higher than application i.e., Analysis, Synthesis and Evaluation	Up to 10 percent

## **B. Practical Work**

Evaluation of student's performance in practical work (Laboratory experiments, Workshop practical's/field exercises) aims at assessing students' ability to apply or practice learnt concepts, principles and procedures, manipulative skills, ability to observe and record, ability to interpret and draw conclusions and work-related attitudes. Formative and summative evaluation may comprise of weightages to performance on task, quality of product, general behaviour and it should be followed by viva-voce.

## **C. Project**

The purpose of evaluation of project work is to assess students' ability to apply, in an integrated manner, learnt knowledge and skills in solving real life problems, manipulative skills, ability to observe, record, creativity and communication skills. The formative and summative evaluation may comprise of weightage to nature of project, quality of product, quality of report and quality of presentation followed by viva-voce.

### **ASPECTS OF QUESTION PAPER SETTING**

Validity and reliability are the most important considerations in the selection and construction of evaluation procedures. First and foremost are the evaluation tools to measure the specific outcomes for which they are intended to measure. Next in importance is reliability, and following that is a host of practical features that can be classified under the heading of usability.

For weightage of marks assigned to formative (internal) and summative (external) evaluation and duration of evaluation has been given in the study and evaluation scheme of the curriculum document. Teachers/Paper-setters/Examiners may use Manual for Students' Evaluation developed by Institute of Research Development & Training, U.P. Kanpur to bring objectivity in the evaluation system. The working group found it very difficult to detail out precisely the contents of subject on languages and therefore teachers may send guidelines to respective examiners for paper setting to maintain objectivity in evaluation.

## RECOMMENDATIONS FOR EFFECTIVE CURRICULUM IMPLEMENTATION

This curriculum document is a Plan of Action (POA) and has been prepared based on exhaustive exercise of curriculum planning and design. The representative sample comprising selected senior personnel (lecturers and HODs) from various institutions and experts from industry/field have been involved in curriculum design process.

The document so prepared is now ready for its implementation. It is the faculty of polytechnics who have to play a vital role in planning instructional experiences for the courses in four different environments viz. class-room, laboratory, library and field and execute them in right perspective. It is emphasized that a proper mix of different teaching methods in all these places of instruction only can bring the changes in stipulated students' behaviour as in the curriculum document. It is important for the teachers to understand curriculum document holistically and further be aware of intricacies of teaching-learning process (T-L) for achieving curriculum objectives. Given below are certain suggestions which may help the teachers in planning and designing learning experiences effectively. These are indicative in nature and teachers using their creativity can further develop/refine them. The designers of the programme suggest every course teacher to read them carefully, comprehend and start using them.

### **(A) Broad Suggestions:**

1. Curriculum implementation takes place at programme, course and class-room level respectively and synchronization among them is required for its success. The first step towards achieving synchronization is to read curriculum document holistically and understand its rationale and philosophy.
2. Uttar Pradesh State Board of Technical Education (BTE U.P.) may make the academic plan available to all polytechnics well in advance. The principals have a great role to play in its dissemination and, percolation up to grass-root level. Polytechnics in turn are supposed to prepare institutional academic plan by referring state level BTE plan.
3. HOD of every Programme Department along with HODs and in-charges of other departments are required to prepare academic plan at department level referring institutional academic plan.
4. All lecturers/Senior lecturers are required to prepare course level and class level lesson plans  
referring departmental academic plan.

### **(B) Course Level Suggestions**

Teachers are educational managers at class room level and their success in achieving course level objectives lies in using course plan and their judicious execution which is very important for the success of programme by achieving its objectives.

Polytechnic teachers are required to plan various instructional experiences viz. theory lecture, expert lectures, lab/workshop practical's, guided library exercises, field visits, study tours, camps etc. In addition, they have to carry out progressive assessment of theory, assignments, library, practicals and field experiences. Teachers are also



required to do all these activities within a stipulated period of 16 weeks which is made available to them in the academic plan at BTE level. With the amount of time to their credit, it is essential for them to use it judiciously by planning all above activities properly and ensure execution of the plan effectively.

Following is the gist of suggestions for subject teachers to carry out T-L process effectively:

1. Teachers are required to prepare a course plan, taking into account departmental academic plan, number of weeks available, course to be taught, different learning experiences required to be developed etc.
2. Teachers are required to prepare lesson plan for every theory class. This plan may comprise of content to be covered, learning material (transparencies, VCDs, Models etc.) for execution of a lesson plan. They may follow steps for preparing lesson plan e.g., drawing attention, state instructional objectives, help in recalling pre-requisite knowledge, deliver planned subject content, check desired learning outcome and reinforce learning etc.
3. Teachers are required to plan for expert lectures from field/industry. Necessary steps are to plan in advance, identify field experts, make correspondence to invite them, take necessary budgetary approval etc.
4. Teachers are required to plan for guided library exercises by identification of course specific experience requirement, setting time, assessment, etc. The tutorial, assignment and seminar can be thought of as terminal outcome of library experiences.
5. Concept and content-based field visits with appropriate releases (day-block) may be planned and executed for such content of course which otherwise is abstract in nature and no other requisite resources are readily available in institute to impart them effectively.
6. There is a dire need for planning practical experiences in right perspective. These slots in a course are the avenues to use problem-based learning/activity learning/experiential learning approach effectively. The development of lab instruction sheets for the course is a good beginning to provide lab experiences effectively.
7. Planning of progressive assessment encompasses periodical assessment in semester, preparation of proper quality question paper, assessment of answer sheets immediately and giving constructive explicit feedback to every student. It has to be planned properly; otherwise, very purpose of the same is lost.
8. The co-curricular activities like camp, social gathering, study tour, hobby club etc. may be used to develop generic skills like task management, problem solving, managing self, collaborating with others etc.
9. Where ever possible, it is essential to use activity-based learning rather than relying on delivery based conventional teaching all the time.
10. While imparting instructions, emphasis may be laid on the development of cognitive, psychomotor, reactive and interactive skills in the students.

11. Teachers may take working drawings from the industry/field and provide practices in reading these drawings.
12. Considerable emphasis should be laid in discipline specific contracting and repair and maintenance of machines, tools and installations.
13. Teachers may take initiative in establishing liaison with industries and field organizations for imparting field experiences to their students.
14. Case studies and assignments may be given to students for understanding of Enterprise Resource Management (ERM).
15. Students be made aware about issues related to ecology and environment, safety, concern for wastage of energy and other resources etc.
16. Students may be given relevant and well thought out minor and major project assignments, which are purposeful and develop practical skills. This will help students in developing creativity and confidence for their gainful employment (wage and self).
17. A Project bank may be developed by the concerned department of the polytechnics in consultation with related Industry, Research Institutes and other relevant field organizations in the state.

## List of Participants

**Workshops were organized at IRDT Kanpur to develop the Curriculum Contents newly introduced course of PG Diploma in Drone Technology for Board of Technical Education, U.P.**

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