GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -IV

Course Title: Total Quality Control
(Course Code: 4345802)

Diploma programmes in which this course is offered	Semester in which offered
Printing Technology	4th Semester

1. RATIONALE

This course deals with quality control methods in printing industry. To understand this course student must have knowledge about printing processes, image generation, printing machine functions and operations. In this course student will acquire the knowledge about quality control tool, equipment, methodology used for quality control. Greater emphasis is laid to understanding the Fundamentals of quality, quality control aids, Management system and Quality standards. For process calibration and standardization of printing process the knowledge of this course is essential.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Apply quality control methods for acceptable print output.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a. Identify quality control stages
b. Use quality control aids effectively
c. Interpret requirements of standards used in printing
d. Apply quality management systems in printing
e. Prepare variable and attribute data from print samples
f. Illustrate control charts for variable and attribute data

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	-	4	4	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs.*Some of the **PrOs** marked **'*'** (in approx. Hrs column) are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Measure density of CMYK patches of given print, printed by offset, digital and screen printing process.	I	02
2	Calculate hue and opacity on given offset print and digital print	I	02
3	Measure Density of CMYK patches printed in color control bar on given offset print	III	02
4	Calculate trapping of RGB patches printed in color control bar on given offset print	III	02
5	Calculate color deviation (Delta E) on given print using Spectrophotometer	III	02
6	Prepare specification chart of parameters recommended by SWOP and measure on news paper	III	02
7	Prepare specification chart of parameters recommended by GRACoL and measure on 4 color Offset Print	III	02
8	Prepare ISO -12647 recommendation & specification for offset and screen Printing	VI	04
9	Understand G7 methodology and prepare report for Offset printing process	VI	06
10	Understand 5S methodology and prepare report for implementation in large scale printing press	III	06
11	Understand six sigma methodology and prepare report for waste minimisation on 4 color sheet fed offset press	VI	06
12	Testing of grey balance using different viewing conditions(Light booth or Viewing booth)	VI	02
13	Finding the pH/Conductivity of the dampening solution.	II	02
14	Measuring grey balance using color control strip.	II	02
15	Determining the print contrast and tonal value of the given sample	II	02
16	Testing of paper grain direction for the paper sample.	I	04
17	Testing of CMYK Inks using draw down test method.	II	04
18	Resistance test of CMYK Inks.	II	04
	Practical Exercises		**56 Hrs.**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *The following are some **sample** 'Process' and 'Product' related skills(more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Preparation of practical set up	10
2	Interpretation of given data and its presentation.	10
3	Process Execution	20
4	Safety measures	20
5	Individual work and working in groups	10
6	Analysis of result of process	20
7	Submission of assigned work in time	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical's in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO.No.
1	**Eye Glass** - min 10x magnification	1 to5
2	**Spectrophotometer -** The instrument should measure both reflected and transmitted colour as well as transmission haze and meet CIE, ASTM and USP guidelines for accurate colour measurement**.** Tristimulus colour calculations are performed from 360 nm to 780 nm Two reflectance measurement areas Automated UV calibration and control Measurement principle: dual-beam spectrophotometer Wavelength resolution: <2 nm Effective bandwidth: 10 nm equivalent triangular Reporting interval: 10 nm Photometric range: 0 to 150% Photometric resolution: 0.003 % Automatic UV control: 400 nm cut off filter for UV control and UV exclusion Measurement time: <5 seconds Colorimetric repeatability: < 0.03 ΔE* CIE L*a*b* on white tile in LAV and SAV modes (20 readings range) < 0.05 ΔE* CIE L*a*b* on blue denim tile in LAV and SAV modes Spectral repeatability: Max 0.20 peak-to-peak between 435 nm and 695 nm	1 to 5

S. No.	Equipment Name with Broad Specifications	PrO.No.
	Interface: RS-232C serial, 19,200 baud, DB9 (female) terminal Operating environment: 10° to 40°C (50° to 104° F), 10 % to 90 % RH, non condensing The instrument should come with software for easy data retrieval and statistical computation Accessories: calibrated instrument white tile, certificate of traceability, black calibration light trap, transmittance zero calibration plate, green diagnostic tile, Wavelength diagnostic filter, reflectance sample clamp, LAV and SAV apertures and other accessories	
3	**Zahn cup and ford cup viscometer** **Zahn Cup:** ASTM D 816, ASTM D 1084,and ASM D 4212 Volume of cup: 44 ml Length of handle: 40 ±0.1 mm Height of cup: 58 ±0.1 mm Measurement of temperature: 25°C ±1.0 °C Material: stainless steel Calibration: certificate included **Ford Cup** **As per ASTM D1200** Diameter orifice: 2.1mm – 5.8mm viscosity range : 10 – 1200 cSt flow times : 30-100 sec Supplied with a certificate of conformity Sheen 406/1, 406/2, 406/3, 406/4 & 406/5 equivalent	17,18
4	Stroboscope - Flash light, blinking control	3,5,6,9,12
5	**Ink proofing kit** Tape width: 20-40 mm Usage: drawdown Model: manual Printing width : 50 mm Printing length: 110 mm Roll diameter: 35 mm Roll length : 50 mm	17,18

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Adopt Ethical Practices.
d) Manage Time
e) Realize the importance of green energy.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Fundamentals of quality**	1a. Understand quality 1b. Describe concept of quality assurance and quality control	1.1 Definition of quality terms 1.2 Quality control process 1.3 Concept of quality, quality cost, quality inspection, 1.4 Quality assurance and quality control, stages of quality control
Unit – II **Quality control aids**	2a. Eelaborate use of quality control tools to measure parameters 2b. Operate quality control equipment properly	2.1 Quality control parameters – density, dot gain, contrast, trapping, delta-E, grey balance 2.2 Quality control tool – colour control bar, slur mark, star target, dot area patches, test forms. 2.3 Color control patches
Unit– III **Quality control standards**	3a. Elaborate requirement of standards 3b. Examine print on standard parameters	3.1 ISO Standards for printing – 12647 3.2 Benefits of working with ISO 12647 3.3 Press calibration to ISO 12647 3.4 Implementation process of ISO standards in printing organization. 3.5 Purpose and application area of SWOP. 3.6 Purpose and application area of GRACOL
Unit– IV **Quality management systems**	4a. Understand quality management systems 4b. Practice methodologies in print industry	4.1 Basic elements of quality management. 4.2 Methodologies of six sigma 4.3 Purpose and application area of "5S". 4.4 The key benefits of six sigma and 5S. 4.5 G7 methodology in Printing Industry.
Unit– V	5a. Understand fundamentals of	5.1 Introduction to statistical process

Statistical quality control	statistical quality control 5b. Draw control charts. 5c. Material Inspection 5d. Testing procedure of materials	Control (SPC) and its applications for print Industry 5.2 Control chart for variables, attributes – X-R chart, P chart, process capability, simple numerical 5.3 Visual inspection 5.4 Storage and handling of substrates and chemicals.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of quality	06	04	04	06	14
II	Quality control aids	05	02	04	08	14
III	Quality control standards	06	02	06	06	14
IV	Quality management systems	06	04	04	06	14
V	Statistical quality control	05	04	04	06	14
Total		**28**	**16**	**22**	**32**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare journals based on practical performed in laboratory.
b) Give seminar on relevant topic.
c) Undertake micro-projects.
d) Visit press setups in local area to observe quality control used during production
e) Visit press setups in local area to observe quality control used during commercial production
f) Visit press setups in local area to observe quality control used during publication job production
g) Visit press setups in local area to observe quality control used during packaging job production
h) Visit press setups in local area to observe quality control used during label job production

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Arrange visit to nearby printing press for understanding various production activities.
g) Use of video/animation films to explain various methods of quality control and equipment used in press
h) Use different instructional strategies in classroom teaching.
i) Demonstration of different small activities related to quality control and checking.
j) Display of various technical brochures of Quality control equipment and tools.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14**-**16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a. Collect the information of various quality control methods used in local area/ city
b. Enlist various software used for the quality control and give details of workflow of software.
c. Collect product samples having defects and quality issues
d. Enlist all the equipment used in quality checking room along with photograph and parallel terminology used by local workers.
e. Collect information about quality standard followed in local press setups.
f. Collect information about latest software and machines used for quality check on inline process
g. Collect production workflow samples of jobs produced in local area press
h. Collect production workflow samples of jobs having different ancillary operations

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Production Planning and Control	Jhamb L.C.	Everest Publishing House, ISBN: 9788186314722
2	Quality Control Handbook	Juran	McGraw-Hill Inc.,US (1 January 1989), ISBN-13: 978-0071005104
3	Statistical Quality Control: A Modern Introduction, 6th edition	DC Montgomery	Wiley, Publications ISBN-10: 8126525061, ISBN-13: 978-8126525065
4	Print and Production Manual	Michael Barnard	Pira International, United Kingdom ISBN 1 85802 238 X
5	Handbook of Print Media	Prof. Dr.-Ing. habil. Helmut Kipphan	Springer-Verlag Berlin Heidelberg New York ISBN 3-540-67326-1
6	SIX SIGMA HANDBOOK	Pyzdek	McGraw-Hill Inc., US, ISBN-10: 9789339221775, ISBN-13: 978-9339221775
7	Critical Appraisal of 5S and Kaizen on Success of SMEs	Chandan Deep Singh	LAP LAMBERT Academic Publishing, ISBN-10 6202025050, ISBN-13 978-6202025058
8	Total Quality Management	Sayankar Vinod	Everest Publishing House, ISBN-10: 8176602671, ISBN-13: 978-8176602679

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=HSigIEs3B3k
b. https://www.youtube.com/watch?v=kEngca8RvCg
c. https://www.youtube.com/watch?v=hQJyXpDKKBg
d. https://www.youtube.com/watch?v=_r9ZUp4N-Ac
e. https://www.youtube.com/watch?v=9WHYXIiLFnE
f. https://www.youtube.com/watch?v=d3PxymtsGAQ
g. https://www.youtube.com/watch?v=5KJ7MdUlIGM
h. https://www.youtube.com/watch?v=oLKq-gmHsV0
i. https://www.youtube.com/watch?v=gL01qR0vVUQ

15. PO-COMPETENCY-CO MAPPING

Semester IV	TOTAL QUALITY CONTROL (Course Code: 4345802)
	POs

Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning	PSO 1 Design and develop the product and process for the need of the industries and society.	PSO 2 Analyze and improve productivity, quality and cost effectiveness for the various pre-press, press and post press process involved in printing to meet the industries requirement.	PSO 3 (If needed)
Competency.	**Apply quality control methods for acceptable print output.**									
Course Outcomes										
CO a) Identify Quality control stages	2	1	1	-	-	-	-	-	2	
CO b) Use quality control aids effectively	2	2	1	-	-	2	2	2	2	
CO c) Interpret requirements of standards used in printing	2	-	-	3	-	-	-	2	2	
CO d) Apply Quality management systems in printing	1	2	-	-	-	2	-	2	2	
CO e) Prepare Variable and Attribute data from print samples	2	-	1	-	-	-	-	2	2	
CO f) Illustrate control charts for	2	1	2	-	-	-	-	-	2	

Variable and Attribute data										

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	V. B. Patel	R. C. Technical Institute, Sola, Ahmedabad	9825219434	vinita_printing@yahoo.com
2	D. D. Raval	R. C. Technical Institute, Sola, Ahmedabad	9879551606	ravaldevang9@gmail.com
3	S. D. Gohel	R. C. Technical Institute, Sola, Ahmedabad	8460609775	sandy_printmedia@yahoo.com