GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Digital Imaging and Colour Management
(Course Code: 4345805)

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

1. RATIONALE

This course deals with digital advancement in graphic art industry. To understand this course student must have knowledge about printer's design. In this course student will acquire the basic knowledge about color, color scanners, color imaging systems. Greater emphasis is laid to understanding the reproduction process utilizing scanners, operating systems, digital image capturing & digital proofing. For digital printing and other printing processes 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:

- **Convert artwork in desired digital format for printing.**

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. Evaluate the given original.
b. Propose type of screen.
c. Convert given original in to digital form.
d. Modify given digital image to print ready format.
e. Apply color management process for the given digital image.
f. Suggest color model for the given digital image.
g. Measure different color parameters.

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	
3	0	2	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'*.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Analyse originals collected from any three sources.	I	2
2	Convert given digital file into print file using RIP operation.	II	2*
3	Use AM, FM, hybrid screen for the print file prepared in practical no. 2.	I	2*
4	Use flatbed scanner for scanning the given pre-printed original.	II	2*
5	Use and practice layer handling tool in Photoshop.	II	2*
6	Use and practice pen tool and paths in Photoshop.	II	2
7	Use and practice masks and channels in Photoshop.	II	2
8	Use and practice filter in Photoshop.	II	2
9	Change image resolutions of given file and suggest required correction.	II	2*
10	Convert given RGB image to CMYK image.	III	2*
11	Edit and re-size image scanned by flatbed scanner.	III	2
12	Edit and re-size digital image captured by mobile phone camera.	III	2
13	Edit and re-size digital images captured by digital camera.	III	2*
14	Use and practice color adjustment hue, contrast, balance, and tone in Photoshop.	IV	2*
15	Use and practice pantone color model to given file.	V	2
16	Prepare four color separations of given print file.	IV	2*
17	Prepare print ready file with preflight check for given job.	III,IV	2
18	Use and practice changee of screen angles during separation for given job.	IV	2
19	Measure density of colour patches using densitometer.	VI	2*
20	Measure L* a* b* value of colour patch using spectrophotometer.	V,VI	2*
21	Calculate color deviation using spectrophotometer.	V,VI	2*
22	Print color charts on two different digital printers.	V	2
	Total		**28**

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	20
2	Setting and Process execution	20
3	Safety measures	20
4	Analysis of result of process	30
5	Submission of report 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 practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	**Flat bed scanner** Scan resolution: 4 800 x 4 800dpi Scan speed (A4, 300dpi): Approx. 8s A4 size, 8 bit, Min. 1200 dpi	4,8
2	**Computer** Windows 11 or Windows 10, 64-bit, with latest Updates Intel Core i3/5/7/9 or AMD Ryzen 3/5/7/9/Threadripper, EPYC OpenCL 1.2-enabled video card with 3+ GB VRAM 8+ GB or more recommended 512 GB or more hard disk space 1280 x 720 screen resolution at 100% (96 dpi) DVD drive optional (for box installation); Internet nodes	4-16
3	**Color printer** A3 Color Laser Printer, Copy and Scan Print speed up to 30 ppm (black), 50 ppm (color) USB 2.0, Ethernet, Hardware Integration Pocket **Black and white printer** Laser printer Multi-function Monochrome Black, toner cartridge Copy and scan print speed up to 30 ppm (black) USB 2.0, Ethernet, Hardware Integration Pocket	22

S. No.	Equipment Name with Broad Specifications	PrO. No.
4	Available Print Software – Adobe Photoshop (version 21.1 and above)	4-13
5	**Densitometer, Spectrophotometer** The instrument should measure both reflected and transmitted color as well as transmission haze and meet CIE, ASTM and USP guidelines for accurate color measurement**.** Tristimulus color 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 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	19-21
6	Raster Image Processor software	2,3,18

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) Follow safety practices.
b) Practice good housekeeping.
c) Work as a leader/a team member.
d) Follow ethical Practices.

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 **Basics of color reproduction**	1a. Identify different originals. 1b. Classify color theories. 1c. Understand basic working of human eye. 1d. Select type of color correction.	1.1 Different types of graphic originals and their characteristics, required physical and optical properties. 1.2 Fundamentals of light and color, color theories, human vision–rods & cones, metamerism and Adaptation, Attributes of color–hue, value, chroma.
Unit – II **Raster image processing**	2a. Explain raster image processing and its function 2b. Describe type of screening. 2c. Use color correction tools to save inks.	2.1 Raster image processing (RIP)-purpose, function, types, ideal and actual reflection of CMY process inks, proportionality failure, additivity failure, 2.2 Color correction tools such as under color removal (UCR), grey component replacement (GCR). 2.3 Study of color separation; color correction, screen angles, filters, spot colors, AM, FM & hybrid screening techniques.
Unit – III **Image capturing devices**	3a. Understand working of scanner. 3b. Describe working of image capturing devices.	3.1 Flatbed scanners- working principle, components of scanner. Factors affecting scan quality, scanning resolution, bit depth of colour-definition and importance, 8 bit RGB. 3.2 Image capturing elements and their working principle, applications, advantages & disadvantages of PMT, CCD, CMOS.

Unit– IV **Data input and output methods**	4a. Understand digital workflow of file processing. 4b. Convert file formats. 4c. Use of preflight check.	4.1 Pixel, resolution, bitmap (raster), vector RGB to CMYK. 4.2 Post script format, Page description language (PDL), PDF formats for printing industry, preflight-purpose, and workflow.
Unit– V **Color management**	5a. Explain color based on device. 5b. Apply color management tools. 5c. Use color gamut to understand limitation of different devices 5d. Explain color profiles.	5.1 Cconcept, purpose, workflow (Device dependent and Device independent colors), advantages. color gamut - definition, color gamut of different processes. 5.2 International color consortium (ICC), Four C's of color management, Test charts for different devices, Production of different color profiles. 5.3 Comparison of profiles, gamut mapping, is rendering intent, perceptual rendering indent, Relative & Absolute colourimetric intent, saturation intent. CIP4. 5.4 Ink saving by Colour profiles and colour gamut.
Unit–VI Color Measurement	6a. Understand various color models. 6b. Use of various color models.	6.1 Physical colour specification systems such as munsell, pantone along with their working principle, advantages, applications and limitations. Standard observer 2^0 and 10^0 6.2 Working principle, advantages, applications & limitations of 3D i.e. solid color space such as CIE Lab, CIE LUV.
Unit– VII **Quality Assurance**	7a. Select screen angle for different jobs. 7b. Describe construction of color measuring instruments. 7c. Convert file sizes. 7d. Identify printing problems. 7e. Measure color values.	7.1 Spectrophotometer, colorimeter, densitometer - working principle, construction and applications. 7.2 Calculations based on DPI, PPI, LPI, resizing, file size, and colour deviation (Delta E), dot area, dot gain, trapping, hue error (simple numerical). 7.3 Maximum printable LPI for different printing processes, substrates and LPI relation.

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	Basics of color reproduction	04	01	02	03	06
II	Raster image processing	04	00	03	03	06
II	Image capturing devices	06	02	04	06	12
III	Data input and output methods	06	02	04	06	12
IV	Color management	08	02	04	06	12
V	Color measurement	08	02	02	06	10
VI	Quality assurance	06	02	04	06	12
Total		**42**	**11**	**23**	**36**	**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 learn workflow of prepress.
e) Visit pre-press setups in local area to learn workflow of commercial job production.
f) Visit Pre-press setups in local area to learn workflow of publication job production.
g) Visit Pre-press setups in local area to learn workflow of packaging job production.
h) Visit Pre-press setups in local area to learn workflow of 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) Guide student(s) in undertaking micro-projects.
g) Arrange visit to nearby printing press for understanding various prepress activities.
h) Use of video/animation films to explain various digital image handling activities.
i) Use different instructional strategies in classroom teaching.
j) Demonstration of different small activities related to color management.
k) Display of various technical brochures of instruments, color charts, pantone shade cards.

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 is 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 prepress department setup installed in local area/ city.
b. Enlist various software used for the designing, imposition, ripping and give details of work flow of software.
c. Collect samples of daily newspapers to analyze print variation and quality checks.
d. Prepare dummy of book work.
e. Collect information from Prepress unit in Local area about software handling, job category and repeat order.
f. Prepare dummy of Carton.
g. Print and display information about colourimeter.
h. Print and display information about spectrophotometer.
i. Collect different specification of scanners and prepare report on it.
j. Print same image with different screen angle conclude results.
k. Print same image with different types of screen and conclude its results.
l. Print same image with different resolutions and conclude its results.
m. Print same image on different substrates and conclude its results.
n. Collect printed color charts.
o. Compare density of process colors printed on coated and uncoated substrates.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Introduction to Prepress	Hugh M.Speirs	PIRA Intentional ISBN:1858029015
2	colour Control in Lithography	Kelvin Triton	PIRA Intentional ISBN:1858020360
3	Color Essentials	Gary G.Field	GATF Press ISBN: 0883623862
4	Print and Production Manual	Michael Barnard	Pira International, United Kingdom ISBN 1 85802 238 X
5	Color & Its Reproduction	Gary G.Field	GATF Press ISBN-13: 978-0883622018
6	Handbook of Print Media	Prof. Dr.-Ing. habil. Helmut Kipphan	Springer-Verlag Berlin Heidelberg New York ISBN 3-540-67326-1

14. SOFTWARE/LEARNING WEBSITES

A. https://www.youtube.com/watch?v=_2LLXnUdUIc – basics of color
B. https://www.youtube.com/watch?v=5Z417hM-RAA – color theory
C. https://www.youtube.com/watch?v=bXoZVDNt7cE – rods and cone function
D. https://www.youtube.com/watch?v=O8U2ctwWXjQ – structure of human visual system
E. https://www.youtube.com/watch?v=yz-tX6GG9Rw – additive and subtractive theory
F. https://www.youtube.com/watch?v=Nuf_SxGk-iE – tristimulus color theory
G. https://www.youtube.com/watch?v=aA4j9zMM2Ds – ultimate guide to computer color
H. https://www.youtube.com/watch?v=vmX8CJjG2yc – color gamut
I. https://www.youtube.com/watch?v=jAbBOyP86k8 – color perception
J. https://www.youtube.com/watch?v=vkOuRKFtNOY -proofing
K. https://www.youtube.com/watch?v=MVMUbKAIr68 – types of scanner
L. https://www.youtube.com/watch?v=z78PBaAldRQ –working of colorimeter
M. https://www.youtube.com/watch?v=pxC6F7bK8CU – working of spectrophotometer
https://www.youtube.com/watch?v=ffWyywysnMw – working of densitometer
N. https://www.youtube.com/watch?v=FMBa5VD5BFU&t=112s – raster image processor

15. PO-COMPETENCY-CO MAPPING

Semester IV	Digital imaging and color management (Course Code: 4345805)								
	Pos								
Competency & Course	PO 1 Basic & Discipline	PO 2 Problem Analys	PO 3 Design/ development of	PO 4 Engineering Tools, Experimenta	PO 5 Engineering practices	PO 6 Project Management	PO 7 Life-long learni	PSO 1 Design and develop the product	Analyze and improve productivity, quality and cost

Outcomes	specific knowledge	is	solutions	tion &Testing	for society, sustainability & environment		ng	and process for the need of the industries and society	effectiveness for the various pre-press, press and post press process involved in printing to meet the industries requirement.	
Competency .	Convert artwork in desired digital format for printing									
Course Outcomes CO a) Evaluate the given original	3	2	-	2	-	-	-	-	2	
CO b) Propose the type of screen	3	-	-	-	2	2	2	-	-	
CO c) Convert given original into digital form	3	2	2	-	-	-	2	-	-	
CO d) Modify given digital image to print ready format	3	2	2	2	-	2	2	2	-	
CO e) Apply color management process for the given digital image	3	2	2	-	-	2	2	-	-	
CO f) Suggest color model for the given digital image	3	-	-	-	-	-	-	2	-	
CO g) Measure different	3	-	-	3	-	-	-	2	-	

colour parameters										

*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

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