guidelines for instructors

masterplan-curriculum for apprentices & trainees

Radio-T.V Mechanic

DEVELOPMENT CELL

FOR SKILLED LABOUR TRAINING

DIRECTORATE OF MANPOWER & TRAINING
GOVERNMENT OF THE PUNJAB
LAHORE

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masterplan-curriculum

for
imparting theory instructions
to
apprentices and trainees

Radio T·V Mechanic

Prepared under the Pakistan - German technical training program.

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INTRODUCTION

With a view to standardizing skilled labour training, functioning under the aegis of the DIRECTORATE OF MANPOWER & TRAINING, PUNJAB, LAHORE, a Development Cell has been set up at this Directorate under the Pak-German Technical Assistance Programme. One of the activities of the Development Cell is to prepare standardized "Training Courses" for various trades.

Skilled manpower is the backbone of industry. Industrial progress is not possible without the availability of systematically trained skilled personnel. The trade proficiency of such a skilled workman does not only depend upon his skills but also upon the knowledge of when and how to apply these skills in any situation that may arise while working on the job. Therefore, a sound understanding of materials, tools, appliances and working methods is a must for every systematically trained skilled workman and the training programme has to fulfil this requirement.

Although skilled workmen must gain broad background information about their respective trade during the course of training, that does not mean they should be imparted highly scientific theory as for engineers and technicians. Practical work is the prime objective in skilled labour training and theoretical knowledge is required to a lesser extent. As such 65% of the training period is devoted to practical work and 35% to that of theoretical instructions.

The Development Cell has therefore prepared the "Masterplan Curriculum" in the subjects of Technology, Technical Mathematics and Technical Drawing for imparting theoretical instructions to apprentices and trainees of the Radio-TV trade. A number of experiments have been worked out as a part of this training in the "Masterplan Curriculum" to emphasize learning by doing.

SET-UP OF THE MASTERPLAN CURRICULUM

The Masterplan Curriculum for Radio-TV Mechanic covers all the necessary requirements for imparting theoretical instructions to apprentices and trainees in their chosen trade. It can be utilized in all training institutions where related theoretical instructions are imparted to apprentices and trainees.

The curriculum has been split up in three main subjects namely Technology, Technical Mathematics and Technical Drawing. These subjects have been divided into units and sub-units. Within one sub-unit topics are specified which show the contents of the lesson to be taught. This will help the instructors to understand the scope of the lesson.

Technology is the main subject, the other subjects deal with the related aspects of Technology on the same teaching day. An extract from the Masterplan Curriculum is shown below as an example of these parallel activities :

Unit No.	TECHNOLOGY	TECHN.MATHEMATICS.	TECHN.DRAWING
17 17.1	Frequency Modulation - frequency modulation frequency deviation and bandwidth - advantage of FM	Frequency deviation - bandwidth of FM oscillation $b = 2\ (\ f + f_{signal})$	FM signal - presentation of FM signal
17.2	Block diagram of FM Receiver - USW tuner - IFamplifier - FM demodulator - AF amplifier	Intermediate frequency 10,7MHZ calculation of : - incoming frequency - oscillator frequency	FM Receiver - block diagram of FM receiver

Every sub-unit has a common serial number for the three subjects namely Technology, Technical Mathematics and Technical Drawing. One week system with 8 - 9 lesson-periods may be followed for imparting theoretical instructions. The break-up of the lesson-periods is as follows :

	4 - 5	lesson-periods	for Technology
	2	lesson-periods	for Technical Mathematics
and	2	lesson-periods	for Technical Drawing .

HOW TO USE THE MASTERPLAN CURRICULUM FOR THE APPRENTICE TRAINING SCHEME

Under the Apprentice Training Scheme the duration of training for Radio-TV Mechanic is three years. This time has been divided into six periods/semesters. The theoretical instructions may be arranged on 1 1/2 days per week. During this time release basis throughout the period of training. A Block Release System may also be followed which provides about 150 days (25 weeks) with 11-12 lesson-periods per week (for Trade Theory and Lab. Experiments)

From the first to sixth semesters a sandwich programme for imparting instructions in Radio-TV Mechanic Trade Theory (Technology, Technical Mathematics and Technical Drawing) as well for Trade Practice practical exercises and Laboratory experiments have been prepared. Radio-TV Trade Theory and Experiments are changing in such a way that first the theoretical background is given in Radio-TV Trade Theory and then the related Experiments are worked out.

At the end of the second to fifth semesters and at the end of sixth semester 2 weeks and one week are provided respectively for the review of the course. One week more is provided at the end of end of each semester for a test.

The time schedule for imparting theoretical instructions (Trade Theory and Laboratory Experiments) to apprentices is shown on page no. 6

MASTERPLAN CURRICULUM

TIME SCHEDULE FOR APPRENTICE TRAINING SCHEME

Semester	Week	Trade theory and labor. experiments	Unit No.
1st Semester	1-15	THEORY	- 5
	16-22	EXPERIMENTS	5 - 22
	23-24	REVIEW	
	25	TEST	
2nd Semester	1-15	THEORY	6 - 8
	16-22	EXPERIMENTS	23 - 33.1
	23-24	REVIEW	
	25	TEST	
3rd Semester	1-15	THEORY	9 - 12
	16-22	EXPERIMENTS	34 - 46
	23-24	REVIEW	
		TEST	
4th Semester	1-15	THEORY	13 - 17
	16-22	EXPERIMENTS	47 - 58.1
	23-24	REVIEW	
	25	TEST	
5th Semester	1-15	THEORY	18 -20,10
	16-22	EXPERIMENTS	59.1 - 86
	23-24	REVIEW	
	25	TEST	
6th Semester	1-15	THEORY	20,11 -22
	16-22	EXPERIMENTS	114-12,3
	23-24	REVIEW	
	25	TEST	

HOW TO USE THE MASTERPLAN CURRICULUM FOR THE TECHNICAL TRAINING SCHEME

Under the Technical Training Scheme the duration of training for Radio-TV Mechanic is two years. This time (2 years) has been divided into four periods/semesters. The theoretical instructions (Trade Training only) may be arranged on 1 1/2 days release Basis througnout the period of training. In addition half a day per week or one day per two weeks may be provided for Laboratory Work (Experiments) from the first semester to the forth semester.

From the first to fourth semesters Trade Theory (Technology, Technical Mathematics and Technical Drawing) and Laboratory experiment have been arranged in such a way that first the theoretical background is given in Radio-TV Mechanic Trade Theory and then the related experiments are worked out.

At the end of each semester one week`s time is provided for test.

The time schedule for imparting theoretical instructions (Trade Theory and Laboratory Experiments) to trainees is shown on page No. 8.

MASTERPLAN CURRICULUM

TIME SCHEDULE FOR TECHNICAL TRAINING SCHEME

	1st SEMESTER		2nd SEMESTER			3rd SEMESTER		4th SEMESTER		
WEEK	1 - 24	25	1 - 23	24	25	1 - 24	25	1 - 23	24	25
TRADE THEORY DAY RELEASE BASIS	THEORY	TEST	THEORY	TEST		THEORY	TEST	THEORY	REVIEW	FINAL TEST
UNIT No.	1 - 8.2		8.3 - 15.7			16 - 20.5		20.6 - 22.2		
LABORATORY EXPERIMENT AND PRACTICAL EXERCIS	FUNDAMENTALS OF METAL TRADE	UNIT No. 1 - 56.3	UNIT No. 57 - 104			UNIT No. 105 - 139.5		UNIT No. 140 - 151.3		

BOOKS AND MANUALS

Text Books

1. Ditrich Volz	Electrical Engineering
2. Europa-Fachbuchreihe (German)	Part I Elektronik 1 (Basic Electronic) Part III Elektronik 3
3. Howard H. Gerrish and William E. Dugger	Electricity and Electronic
4. Bernard Grob	Basic Electronic Basic Television
5. Van Valkenburgh	Basic Electronics Part one to six
6. R R Gulati	Monochrome and Colour Television

LIST OF EXPERIMENTS

1. Use of volt - and ampere meter
2. Use of multi-meter
3. Scale reading exercise
4. Measuring exercise of resistance (PTC and NTC)
5. Series connection - extension of V-meter
6. Parallel connection - extension of A-meter
7. Measuring exercise with Ohm - meter and wheatstone bridge
8. Measuring exercise of electrical power
9. Introduction of oscilloscope
10. Measuring exercise of voltage - and current with oscilloscope
11. Measuring exercise of time and frequency with oscilloscope
12. Measuring exercise of capacitor
13. Measuring exercise of coil
14. Measuring exercise of characteristic curve of germanium diode
15. Measuring exercise of characteristic curve of silicon diode
16. Measuring exercise of characteristic curve of valve diode
17. Measuring exercise of semiconductor diodes (check unknown diodes of material and electrodes)
18. Measuring exercise of transistor (check unknown transistor of material, electrodes and NPN or PNP type)
19. Measuring exercise of characteristic curve of transistor

20. Measuring exercise of characteristic curve of triode

21. Measuring exercise of parallel resonant circuit

22. Measuring exercise of high - and low pass filter

23. Measuring exercise of band pass filter

24. Measuring exercise of band stop filter circuit

25. Measuring exercise of integrating - and differentiating circuit

26. Measuring exercise of DC power supply

27. Measuring exercise of Z-diode

28. Measuring exercise of regulated transistorized power supply

29. Measuring exercise of common base - emitter - and collector circuit

30. Measuring exercise of grounded cathode-, grid - and anode circuit

31. Measuring exercise of push pull amplifier with valve

32. Measuring exercise of push pull amplifier transistorized

33. Measuring exercise of push pull amplifier with complementary circuit

34. Measuring exercise of oscillator circuits

35. Measuring exercise of RC - generator

36. Measuring exercise of astable multivibrator

37. Measuring exercise of amplitude modulation

38. Measuring exercise of O.P. - amplifier with inverse and not inverse input

39. Measuring exercise of active low - and high pass filter with O.P. amplifier

40. Measuring exercise of O.P. amplifier with power output stage

41. Measuring exercise of tunnel diode

42. Measuring exercise of field effect transistor

43. Measuring exercise of capacitor diode

44. Measuring exercise of unijunction transistor

45. Measuring exercise of thyristor

MASTERPLAN CURRICULUM

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
1. 1.1	Electricity Theory of atomic structure and electrical charge - atomic structure - charge of protons and electrons - force between equal & opposite charges	Transpostition of Equations - exchangeable sides of a scale - addition & substraction	Symbols of Electrical Circuits
1.2	Electrical Voltage and Electrical Current - how to generate EMF - current as a movement of electrons - direction of current	Transposition of Formula - exercises with simple already known formula, addition and subtraction	Symbols of Electronic Circuits
1.3	Electrical Conductor and Insulator - material of conductor - characteristics and behaviour of conductor - material of insulator - characteristics and behaviour of insulator - application of conductor and insulator	Transposition of Equations and Transposition of Formula - exchangeable sides of a scale, multiplication and division - exercises with simple already known formula, multiplication and division eg. $A=\frac{l \times h}{2}$	Meter Connection - simple electric circuits, connection of volt and ampere meter with power supply and consumer

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
2. 2.1	Direct Current Resistance and Conductance - resistance depending upon material, length and cross-section - unit of resistance - materials for resistors - specific resistance - colour code of resistance - conductance and conductivity	The Resistance of Wire - calculation of R, l, A by applying of formula $R=\frac{\rho \times l}{A}$ $R=\frac{1}{\varkappa \times A}$ $G=\frac{1}{R}$ $\varkappa = \frac{1}{\rho}$ (instead of $\varkappa$ use of σ possible)	Meter Connection - internal connection of ohmmeter
2.2	Ohm's Law - relation between I and V (R const.) - relation between I and R (V const.) - ohm's law $I = \frac{V}{R}$	Ohm's Law - calculation of current, voltage and resistance: $I = \frac{V}{R}$ $V = I \times R$ $R = \frac{V}{I}$	Ohm's Law - circuit diagram for determining resistance with indirect measure method - graph of different resistance by changing the applied voltage
2.3	Resistance and Temperature - dependance of resistor upon temperature - temperature coefficient - behaviour of PTC resistor - behaviour of NTC resistor	Resistance and Temperature - calculation of: $\Delta R = R_{cs} \times \alpha \times \Delta \vartheta$ $R_{hs} = R_{cs} + \Delta R$	Resistance and Temperature - graph of NTC and PTC by changing the temperature

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
2.4	Series Connection of resistances - definition of series connection - current in series connection - ration of total resistance and individual resistance - ration of individual voltage to individual resistance - total voltage and individual voltage (kirchoff' s second law $V = V_1 + V_2 + V_3 \ldots\ldots$)	Series connection - calculation of: $I = I_1 = I_2 = I_3 \ldots\ldots$ $V = V_1 + V_2 + V_3 \ldots\ldots$ $R = R_1 + R_2 + R_3 \ldots\ldots$ $V_1 : V_2 = R_1 : R_2$	Series connection - complete circuit diagram of series connection with volt and ampere meter - circuit diagram of multi-range voltmeter
2.5	Parallel connection of resistance - definition of parallel connection - voltage in a parallel circuit - equivalent (total) resistance in parallel circuit - total current and individual currents (kirchoff's first law: $I = I_1 + I_2 + I_3 \ldots\ldots$)	Parallel connection - calculation of: $V = V_1 = V_2 = V_3 \ldots\ldots$ $I = I_1 + I_2 + I_3 \ldots\ldots$ $\frac{I}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \ldots\ldots$ $G = G_1 + G_2 + G_3 \ldots\ldots$ $I_1 : I_2 = R_2 : R_1$	Parallel connection - circuit diagram of parallel connection with volt and ampere meter - circuit diagram of multi-range amperemeter

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
2.6	Series - Parallel connection of resistances - definition of series - parallel connection - current in a series - parallel connection - voltage in a series - parallel connection - total resistance	Series - Parallel connection - individual and total voltage - individual and total current - individual and total resistance	Series - Parallel connection - circuit diagram of internal connection of a multimeter
2.7	Voltage divider - definition of voltage divider - constant and variable voltage divider - load and non-load characteristic	Voltage divider - calculation of: non-load condition $V_2 = V - V_1$ $V_1 = \frac{R1}{R2} \times V_2$ load condition $I = IR_2 + IR$ load $V_1 = I \times R_1$ $V_2' = IR_2 \times R_2$ Demand for practice $IR_2 = 4 \times I_{load}$ $R_{load} = 4 \times R_2$	Voltage divider - representation of: . voltage divider with constant resistances . variable voltage divider . diagram of output voltage of no load and loading divider

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
2.8	Bridge circuit - wheatstone bridge circuit - construction and function - balancing condition	Bridge Circuit - calculation of: $\frac{R1}{R2} = \frac{R3}{R4}$ $\frac{R1}{R2} = \frac{Rx}{R4}$	Bridge circuit - circuit diagram of wheat-stone-meter
3 3.1	Power and Energy Electrical power - definition of electrical power - unit of power - relation of current and power - relation of voltage and power - measuring methods of power	Electrical power - calculation of: $P = V \times I$ $P = I^2 \times R$ $P = \frac{V^2}{R}$	Electrical power - circuit diagram for indirect measuring method - circuit diagram of direct measuring method
3.2	Electrical energy and efficiency - definition of electrical energy - unit of electrical energy - definition of efficiency	Electrical energy and efficiency - calculation of: $W = Pxt$ charges(c)=W x energy-price(p) c total = W x P + basic tarif. $P_{loss} = P_{in} - P_{out}$ $\eta = \frac{P_{out}}{P_{in}}$	Electrical energy - connection of energy meter

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
4	Chemical Effect on Electrical Current		
4.1	Electrolysis - distilled water as non-conductor - conducting liquids - movement of charges in liquids - metal plating - electrolytic copper	Deposition of substances due to electrolysis - calculation of: . equivalent weights of material per Ah . amount of substance deposited $m = c \times I \times t$	Galvanic cell - connection of cells to provide different voltage
4.2	Galvanic cell - electro chemical voltage series - material of cells - polarisation and depolarisation - construction of cells	Galvanic cell - calculation of: . total voltage of series connection . current load of parallel connection	Galvanic cell - sectional drawing of different dry cell
4.3	Characteristics of power source - internal resistance - voltage drop depends on relation between internal and load resistance - characteristics of: no load operation short circuit operation power adaptation - measuring methods of internal resistance	Internal resistance - calculation of: . $I = \frac{E}{R_i + R_{load}}$. $R_i = \frac{E-V}{I}$	Internal resistance - representation of circuit diagrams for different measuring methods - loading method $\frac{E}{2}$ ($R_i = R_{load}$) method

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
5. 5.1	Alternating Current Origin of A.C and quantities - inducted voltage - sine curve of induced voltage - period T, frequency f, wave length λ and angular frequency ω - effective- and maximum values	Basic quantities and effective values - period and frequency $T = \frac{1}{f}$ (apply f in mH, kHz, MHz and GHz) - Wavelength $= \frac{vo}{f}$ - angular frequency $= 2 \times \pi \times f$	Origin of A.C. voltage - development of sine curve - vector and line diagrams
5.2	Ohmic resistance in A.C. - sine curve of voltage and current - power of an ohmic resistance	Effective values - calculation of: . $V_{eff} = \frac{V_{max}}{\sqrt{2}} = 0.707 \times V_{max}$. $I_{eff} = \frac{I_{max}}{\sqrt{2}} = 0.707 \times I_{max}$. $V_{eff} = \frac{V_{pp}}{2 \times \sqrt{2}}$; $V_{eff} = \frac{V_{max}}{\sqrt{2}}$. Ohmic resistance in AC, $R = \frac{V}{I}$	Ohmic resistance in A.C. - representation of I-and V-line diagram - construction of power curve out of I and V

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
6	<u>Electrical Capacity</u>		
6.1	<u>The capacitor</u> - electric field, dielectric polarization and dielectric constant ε_0, ε_r - capacity and unit - parallel and series connection - types of capacitors	<u>The capacitor</u> - electric charge $Q = C \times V$ - capacity $C = \frac{\varepsilon_0 \times \varepsilon_r \times A}{d}$ - parallel connection $C = C_1 + C_2 + C_3 \ldots$ - series connection $\frac{1}{C} = \frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} \ldots$	<u>The capacitor</u> - connection of capacitors
6.2	<u>Capacitor in DC</u> - charging and discharging - behaviour of capacitor in DC - time constant	<u>Capacitor in DC</u> - time constant $\tau = R \times C$ - total charging / discharging time $t_{tot} = 5 \times \tau$	<u>Capacitor in DC</u> - charging and discharging curves - representation of time constant τ
6.3	<u>Capacitor in AC</u> - capacitive reactance X_C - reactive current - sine curve of voltage and current - phase displacement between V and I	<u>Capacitor in AC</u> - capacitive reactance $X_C = \frac{1}{2\pi f \times C} = \frac{1}{\omega \times C}$	<u>Capacitor in AC</u> - wave diagram of voltage and current - representation of phase angle φ

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
7	Magnatic effect of electrical current	Trigonometrical rations	
7.1	Permanent magnetism - magnetic poles - force between the poles, repulsion - attraction - magnetic field - magnetic materials - permeability and remarence	Triangle - calculation of: . right angles triangles . theory of Pythagoras	Permanent magnetism - magnetic lines of forces of a permanent magnet
7.2	Electromagnetism - magn. field of a current carrying conductor - magn. field between parallel conductors - direction of magn. field lines - magnetomotive force and magnetizing force - magn. flux and flux density	Magnetical calculation - magnetic conductivity $\mu = \mu_o \times \mu_r$ - magnetomotive force $F = I \times N$ - magnetizing force $H = \frac{I \times N}{l}$ - flux density $B = \mu_o \times \mu_r \times H$ - magn. flux $\Phi = B \times A$	Magnetic lines of forces representation of magnetic lines - single conductor - parallel conductor - of a coil
7.3	Induced voltage - generation of induced voltage - direction of current generator rule - lenz's law - magnitude of induced voltage	Sine and Cosine of an angle - ration between perpendicular and hypothenuse - finding sine out of tables - ration between base and hypothenuse - finding cosine out of tables	Magnetizing curves representation of: - magnetic hysteresis loop of hard and soft magnetic material

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
7.4	<u>Self induction and inductance</u> - self induction voltage - direction and magnitudes of self induction voltage - unit of inductance	<u>Connection of inductances</u> - unit and subunits of inductance H, mH, H - series connection $L = L_1 + L_2 + L_3 \ldots\ldots$ - parallel connection $\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} \ldots\ldots$	<u>Self induction voltage</u> - presentation of induced voltage and magnetic flux
7.5	<u>Eddy current</u> - formation of eddy current - effect of eddy current - methods to prevent eddy current	<u>Power and roots</u> - value of power exponent base - addition, $5a^2 + 3a^2 = 8a^2$ - subtraction, $5a^2 - 3a^2 = 2a^2$ - multiplication, $a^2 \times a^3 = a^5$ - finding square number and square root out of table	<u>Self induction voltage continuous</u> presentation of: - applied voltage, - magnetic flux lines - self induction voltage in circuit diagram
7.6	<u>Coil in direct current</u> - behaviour of voltage, current and resistance by on-off operation - time constant τ	<u>Coil in direct current</u> calculation of: - $R_L = \frac{1 \times \rho}{A}$ - $\tau = \frac{L}{R}$	<u>Coil in direct current</u> - shape of voltage and current curve as a function of time by on-off operation representation of τ

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
7.7	Coil in AC - effective resistance - inductive reactance X_1 - apparent resistance Z (impedance) - sine curve of voltage and current - phase displacement between V and I	Coil in AC - ohmic voltage drop $V_R = I \times R$ - inductive voltage drop $V_L = I \times X_L$ - voltage drop across apparent resistance $V = \sqrt{V_R^2 + V_L^2}$ - apparent resistance $Z = \sqrt{X_L^2 + R^2}$ - phase displacement $\cos \varphi = \frac{R}{Z}$ - finding of $\sphericalangle \varphi$ (angle of phase difference) out of table	Coil in AC wave diagram of: - voltage and current - representation of phase angle φ
7.8	Transformer - construction and working principle - transformation of voltage current and impedance - ratio between current and turns - ratio between voltage and turns - power and efficiency - auto transformer	Transformer - $\frac{V1}{V2} = \frac{N1}{N2}$, $r = \frac{V1}{V2} = \frac{N1}{N2}$ - $\frac{V1}{V2} = \frac{I2}{I1}$, $r = \frac{V1}{V2} = \frac{I2}{I1}$ - $Z_1 = \frac{V1}{I1}$, $Z_2 = \frac{V2}{I2}$ - $r = \frac{Z1}{Z2}$ - $\eta = \frac{P_{out}}{P_{in}}$	Transformer Circuit with transformer: - single phase transformer - tapped-output transformer - auto transformer

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
8 8.1	Active Components Principles of semi-conductor - structure of germanium crystal - intrinsic conductivity and charge carrier - P and N doping, P-type and N-type semiconductor - doping elements - P.N. junction without extern voltage, diffusion current, depletion zone - P.N. junction with extern voltage	R e v i e w	Principle of semiconductor Presentation of semiconductor crystal - a) P doping-type - b) N doping-type
8.2	Semi-conductor diode - structure, symbol and electrodes - characteristic curve, pass and blocking range - forward voltage V_F reverse current I_R forward current I_F and reverse voltage V_R, reverse and forward resistance - difference between germanium, and silicon diodes	Semi-conductor diode - finding of V_F, I_F, V_R and P_{total} out of specification sheet - calculation of direct current resistance $R_F = \frac{V_F}{I_F}$ with use of diode characteristic curve - calculation of dynamic resistance $r_F = \frac{\Delta V_F}{\Delta I_F}$ with use of diode characteristic curve	Semi-conductor diode - diode used as electronic switch - diode used as power limiter eg. solder iron

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
8.3	<u>Principles of transistor</u> - structure of PNP and NPN transistor, symbol and electrodes - voltage and current divide of transistor - in-put and out-put voltage - in-put and out-put resistance	<u>Principle of transistor</u> - $I_E = I_C + I_B$ - $V_{CE} = V_{BE} + V_{CB}$ - direct current amplification $B = \frac{I_C}{I_B}$	<u>Semiconductor diode</u> representation of: - characteristic curve of diode
8.4	<u>Radio vacuum tube</u> - structure, characteristics, application and working principle of diode and triode	<u>Vacuum tube diode</u> - mutual conductance $G_m = \frac{\Delta I_a}{\Delta V_a}$ - internal resistance $R_i = \frac{\Delta V_a}{\Delta I_a}$	<u>Internal structure of valve</u> representation of: - fillament - cathode - control grid - screen grid - anode
8.5	<u>Radio vacuum tube</u> - structure characteristics, application and working principle of Tetrode and Pentode	<u>Vacuum tube triode</u> - mutual conductance $G_m = \frac{\Delta I_a}{\Delta V_{gk}}$ - internal resistance $R = \frac{\Delta V_a}{\Delta V_{gk}}$ - voltage gain $\mu = \frac{\Delta V_a}{\Delta V_{gk}}$	<u>Valves</u> representation of: - characteristic curve of diode $I_a - V_a$

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
8.6	Cathode ray tube - structure, characteristic, application and working principle of cathode ray tube	Vacuum tube pentode - mutual conductance G_m - internal resistance R_i - voltage gain μ	Valves continuous - characteristic curve of $I_a - V_a$ for triode and pentode
9 9.1	RL and RC Circuits RL-series and parallel connection - total voltage V - apparent resistor (impedance) - total current I	RL-series and parallel connection - $V = \sqrt{V_R^2 + V_C^2}$ - $Z = \sqrt{R^2 + X_C^2}$ - $I = \sqrt{I_R^2 + I_L^2}$ - $\cos \varphi = \frac{R}{Z}$ - exercise to find $\sphericalangle \varphi$ out of table	RL-series and parallel connection representation of: - wave diagram of voltage V_R, V_L and V_{total} - wave diagram of current I_R, I_L and I_{total}

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
9.2	RC-series and parallel connection - total voltage V - apparent resistor (impedance Z) - total current I	RC-series and parallel connection - $V = \sqrt{V_R^2 + V_C^2}$ - $Z = \sqrt{R^2 + X_C^2}$ - $I = \sqrt{I_R^2 + I_C^2}$ - phase displacement $\cos \varphi = \frac{R}{Z}$ - exercises to find $\sphericalangle \varphi$ out of tables	RC-series and parallel connection representation of - wave diagram of voltage V_{R}, V_C and V_{total} - wave diagram of current I_R, I_C and I_{total}
9.3	R.L.C.-series connection - vector diagram for voltage when $X_L > X_C$ - vector diagram for voltage when $X_L < X_C$ - vector diagram for voltage when $X_L = X_C$	R.L.C.-series connection - total voltage $V = \sqrt{V_R^2 \quad \Delta V_X^2}$ - apparent resistor $Z = \sqrt{R^2 + \Delta X^2}$ - apparent power $Pa = \sqrt{P^2 + \Delta P_r^2}$	R.L.C.-series connection - wave diagram of voltage (V_R) (V_L) (V_C) (V_{total})
9.4	R.L.C-parallel connection - vector diagram for current when $I_L > I_C$, $I_L < I_C$, $I_L = I_C$	R.L.C.-parallel connection - total current $I = \sqrt{I_R^2 + \Delta I_X^2}$ - apparent power $Pa = \sqrt{P^2 + \Delta P_r^2}$	R.L.C.-parallel connection - wave diagram of current (I_R), (I_L), (I_C), (I_{total})

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
9.5	Series and parallel resonance circuit - meaning of resonance - resonance frequency - relations of currents, voltages and resistances of series and parallel resonant circuits - resonant impedance, quality, damping and band-width	Series and parallel resonance circuit - resonance frequency $f_{res} = \frac{1}{2\pi\sqrt{L \times C}}$ - $X_L = X_C$ - $I_L = I_C$ - Quality $Q = \frac{I_X}{I}$, $Q = \frac{V_X}{V}$ - damping $d = \frac{1}{Q}$ - bandwidth $b = \frac{f_{res}}{Q}$, $b = \Delta f$ $b = f_{high} - f_{low}$	Series and parallel resonance - diagram of series resonant circuit - diagram of parallel - resonant circuit
9.6	High and low pass filter - construction of high and low pass circuits - component voltage - curve of voltage depends on frequency - critical frequency of filter	High and low pass filter - critical frequency $f_{cr} = \frac{1}{2\pi R \times C}$ - $V_R = V_C = \frac{V}{\sqrt{2}} = 0.707 \times V$	High and low pass filter - diagram of RC and RL high pass filter - diagram of RC and RL low pass filter

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
9.7	Band pass and band stop filter - construction of band pass and band stop filter - frequency response - filter coupling	Band pass and band stop filter - centre frequency $f_{ce} = \frac{1}{2\pi\sqrt{L1 \times C1}}$ $\frac{1}{2\pi\sqrt{L2 \times C2}}$ - bandwidth $b = f_{high} - f_{low}$	Band pass and band stop filter - circuit diagram of band pass band stop filter
9.8	Integrating and differentiating circuits - construction of integrating and differentiating circuits - pulse time - output voltage depends on time constant	Integrating and differentiating pulse calculation of: - rise time t_r - fall off time t_f - pulse time t_p, - break time t_b - pulse duration time T	Integrating and differentiating - integrating and differentiating circuits - representation of rise time t_r fall off time t_f pulse time t_p break time t_b pulse duration T

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
10	Powersupply		
10.1	Rectifier and filter circuits - half wave rectification - full wave rectification, bridge, circuit - RC and LC filter circuit	Filter circuits calculation of: - smoothing factor $S_m = \frac{V_{1\sim}}{V_{2\sim}}$; $S_m = S_{m1} \times S_{m2}$	Rectifier and filter circuits - circuit diagram of half wave rectification - circuit diagram of full wave rectification (bridge circuit) - RL and RC filter circuit connection with rectifier
10.2	Zener diode - characteristic curve zener effect and operating range - leakage power, dynamic internal resistance - need of series resistance - voltage stabilization	Zener diode - series resistance $R_s = \frac{V_{total} - V_z}{I_z + I_L}$ - dynamic resistance $r = \frac{\Delta V_R}{\Delta I_R}$ using of characteristic curve - stability factor $S_t = \frac{\Delta V_{total} \times V_z}{V_{total} \times \Delta V_z}$	Zener diode - voltage stabilization circuit - ripple filter circuit eg. rectifier with charging capacitor series resistance and Z-diode

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
11	Transistor and valves amplifier		
11.1	Transistor amplifier - common base emitter and collector collector circuit - adjustment and stabilization of operation point - voltage current and power amplification	Single ended transistor amplifier - characteristics of operation point P_t, V_{CE}, I_C and B - base potential divider $R_1 = \frac{V_b - V_{BE}}{10 \times I_B}$ $R_2 = \frac{V_{BE}}{I_{R1} - I_B}$	Transistor basic circuits - common base circuit - common emitter circuit - common collector circuit
11.2	Valves amplifier - grounded - cathode - grid and anode circuit - adjustment and stabilization of operation point - voltage amplification	Single ended transistor amplifier - calculation of load resistance (stage without current feed back) $R_L = \frac{V_b - V_{CE}}{I_C}$	Valve basic circuit - grounded cathode grid and anode circuit
11.3	Power amplifier characteristic of: - class A, B, AB & C amplifier, operation point and out-put signal - feed-back in amplifier circuit - coupling of multi-stage amplifier	Single ended transistor amplifier - calculation of load resistance (stage with current feed back) $R_L = \frac{V_b - (V_{CE} + V_{RE})}{I_C}$	Power amplifier representation of: - characteristic curve with operation point of class A and C amplifier

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
11.4	<u>Single ended amplifier valve/transistor</u> - circuit of valve type - function of valve type - circuit of transistor type - function of transistor type	<u>Single ended transistor amplifier</u> calculation of: - emitter resistance $R_E = \frac{V_E}{I_E}$	<u>Transistor amplifier</u> - circuit diagram of single ended transistor amplifier
11.5	<u>Push pull amplifier valve/transistor</u> - circuit and function of valve type - circuit and function of transistor type with 2 transformers	<u>Single ended transistor amplifier</u> calculation of: - emitter capacitor $C_E = \frac{1}{2\pi f \times R_E}$	<u>Valve amplifier</u> - circuit diagram of single ended valve amplifier
11.6	<u>Push pull amplifier / transistor</u> - circuit and function of transistor type with single transformer - circuit and function of complementary circuit	<u>Single ended transistor amplifier</u> - coupling capacitor $C_c = \frac{1}{2\pi f \times R_{input}}$	<u>Transistor amplifier</u> - circuit diagram of single ended multi-stage amplifier

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
12 12.1	**Oscillator Circuits** Principles of oscillator - the components of oscillator circuit - feed back of amplitude and condition of phase	Oscillator - calculation of f_{res} for resonance circuit	Oscillator - circuit diagram of armstrong oscillator - circuit diagram of hartley oscillator
12.2	Types of oscillator structure and working principle - Meissner (Armstrong) oscillator - Hartley oscillator - Collpits oscillator - Crystal oscillator - Multivibrator	Oscillator - LC oscillator $f = \frac{1}{2\pi\sqrt{L \times C}}$ - multivibrator $\tau_p = 0{,}69 \times R \times C$ $\tau_i = 0{,}69 \times R \times C$ $T = \tau - \tau_p$ $f = \frac{1}{T}$	Oscillator - circuit diagram of crystal oscillator - circuit diagram of RC generator
13 13.1	**Modulation** Amplitude modulation - why modulation is necessary - RF signal carrier frequency - AF signal modulation frequency - envelope and side bands - modulation wave - modulation factor - modulation circuit	Amplitude modulation - modulation factor $m_f = \frac{V_s \max}{V_c \max}$ band width $b = 2 \times f_s \max$	Amplitude modulation representation of: - AF signal - carrier wave with audio envelope lower and upper side band

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
14 14.1	Antennas Radio antennas - structure working principle and application of dipole-long wire-rod and ferrit antennas - impedance matching between antenna, transmission line and receiver	Radio Antennas LMS antenna - effective height of rod antenna USW antenna - Yagi antenna, dipole $\frac{\lambda}{4}$ director $\frac{\lambda}{4}$ - 2,5 % reflector $\frac{\lambda}{4}$ + 2,5 %	Amplitude modulation continuous
15 15.1	Principle of radio transmitting and receiving Transmitting - block diagram - working principle of different stages - signal transmission	Radio antenna continuous - distance dipole/reflector 0.15 x λ - distance dipole/director 0.1 x λ	Radio transmitting - block diagram of AM transmitter
15.2	Principle of TRF and superheterodyne receiver - block diagram of TRF receiver - block diagram of superheterodyne receiver - principle of heterodyning	Frequency and wave length calculation of wave length for: - long wave 150 - 285kHz - medium wave 510 - 1605kHz	TRF and superheterodyne receiver - block diagram of TRF receiver - block diagram of superheterodyne receiver

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15.3	<u>RF tuning</u> - RF - circuit - tuning of resonance circuit - connection of input resonance circuit and oscillator	<u>Frequency and wave lenght</u> - short wave 5.95 - 17.9 MHz - USW 87.5 - 104 MHz	<u>RF stage</u> - circuit diagram of tuning stage
15.4	<u>Mixer stage transistor/valve</u> - conversion of frequency through mixing - working principle of mixer stage - output signal of mixer stage - image frequency f_m	<u>Mixer stage</u> calculation of: - oscillator frequency $f_o = IF + f_{in}$ - image frequency $f_m = f_{in} + 2 \times IF$	<u>RF stage continuous</u> - circuit diagram of oscillator and mixer stage - transistor and valve
15.5	<u>Intermediate frequency amplifier (AM) valve/transistor</u> - importance of IF - resonance amplifier - IF - Transformer	<u>Intermediate frequency</u> - intermediate frequency $IF = f_o - f_{in}$	<u>Intermediate frequency/AM range</u> - diagram of frequency response of IF amplifier

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
15.6	Amplitude demodulator, valve/transistor - input signal - rectification of AM signal - demodulator circuit - kind and function of automatic gain control AGC	Automatic gain control AGC - calculation of RC filter for AGC	Amplitude demodulator - diagram of: - AM demodulator circuit (semi-conductor diode valve diode) - representation of outcoupling AF and AGC signal
15.7	Volume control - function of volume control - tone control, treble and bass	R E V I E W	Amplifier - circuit diagram of ton control circuit
15.8	R E V I E W	R E V I E W	R E V I E W

Unit No	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
16 16.1	<u>Electro Acoustic Converters</u> <u>Microphone</u> - structure and function of: carbon-dynamic and crystal microphone	<u>Power amplifier (repetition)</u> calculation of: - base voltage divider R_1 and R_2 - load resistance R_L	<u>Push pull amplifier</u> - circuit diagram of valve push pull amplifier
16.2	<u>Loudspeaker</u> - structure and function of: - permanent magnet loudspeaker - electrodynamic loudspeaker - headphone	<u>Power amplifier (repetition)</u> calculation of: - emitter resistance R_E - emitter capacitor C_C	<u>Push pull valve amplifier continuous</u>
16.3	<u>Phonograph</u> - structure and function of: crystal pick up, mono type and stereo type - structure and function of magnetic pick-up, mono type and stereo type	<u>Power amplifier (repetition)</u> calculation of: - coupling capacitor C_C	<u>Push pull amplifier</u> circuit diagram of: - transistorrized push pull amplifier with two transformers
16.4	<u>Magnetic tape and cassette recorder</u> - principle of magnetic tape - structure and function of play and erase head - magnetic record method	<u>Power amplifier</u> calculation of: - transformer impedance Z	<u>Push pull transistorized amplifier continuous</u>

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
16.5	Magnetic Tape and cassette recorder - introduction to mechanical system of tape and cassette recorder	Power amplifer continous calculation of: - transformer ratio r	Push pull amplifier transistorized push pull amplifier with single transformer
16.6	Sound systems - mono type - stereo type - difference between mono and stereo system - setting of loudspeakers for stereo system	Push pull out put amplifier calculation of: - transformer impedance Z - output transformer ratio r	Push pull amplifier circuit diagram of: - complementary circuit
17 17/	Frequency Modulation - frequency modu lation frequency deviation and bandwidth - advantage of FM	Frequency deviation - band-width of FM Oscillation $b = 2 (\Delta f + f_{signal})$	FM signal - presentation of FM signal
17.2	Block diagram of FM Receiver - USW tuner:preliminary stage Oscillator mixer - IF amplifier - FM demodulator - AF amplifier	Intermediate frequency 10.7MHZ calculation of: - incomming frequency - oscillator frequency	FM REceiver - block diagram of FM receiver

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17.3	Intermediate frequency amplifier (IF) - intermediate frequency 10,7 MHZ - bandpass and amplifier circuits - working principle of IF stage for 455 kHZ (AM) and 10,7 MHZ (FM)	Intermediate frequency calculation of: - IF for FM and AM receiver	Intermediate frequency - IF amplifier stage for 455 kHZ and 10,7 MHZ
17.4	FM demodulator - working principle of ratio detector	R E V I E W	FM demodulator - circuit diagram of ratio, detector
18 18.1	Special semiconductor components Integrated circuits (IC'S) - definition of IC - principle of construction technics - terminal diagram - types of IC's - application	OP amplifier calculation of: - voltage amplification without inverse feed back $\mu_V = \frac{V_{out}}{V_{in}}$ - voltage amplification with inverse feed back $\mu_V = \frac{R_2}{R_1}$	OP amplifier - circuit diagram for offset compensation - circuit diagram for frequency compensation - circuit diagram for not inverse amplifier - circuit diagram for inverse amplifier

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18.2	OP amplifier - symbol - inverse and not inverse input - output - different application of OP amplifier	OP amplifier continuous calculation of: - dynamic input resistance $r_i = \frac{\Delta V_{in}}{\Delta I_{in}}$ - dynamic output resistance $r_{out} = \frac{\Delta V_{out}}{\Delta I_{out}}$	OP amplifier continuous - active low- and high pass filter - OP with power output stage
18.3	Tunnel diode - structure and symbol - characteristic curve and working principle - operation (tunnel) range - application	Tunnel diode calculation of dynamic resistance - $r = \frac{\Delta V}{\Delta I}$ with using the diode characteristics curve	OP amplifier continuous circuit diagram of: - summing amplifier - subtraction amplifier
18.4	Field effect transisitor - structor, symbol and electrodes - working principle and characteristics - application	Field effect transisitor - mutual conductanct $Gm = \frac{\Delta ID}{\Delta V_{GS}}$ with help of characteristic curve - dynamic resistance $r = \frac{\Delta V_{DS}}{\Delta I_D}$ with help of characteristic curve	Field effect transisitor amplifier diagram of - common source circuit - common drain circuit - common gate circuit

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18.5	Capacitor diode - structure and symbol - characteristic curve in reverse direction (operation range) - working principle - application	Field effect Transistor continuous	Capacitor diode circuit diagram of: - oscillator with capacitor diode
18.6	Unijunction transistor - structure, electrodes and symbol - working principle - application	Unijunction transistor - supply voltage $V=V_{B1}+V_{BB}+V_{B2}$ - $V_{EB1} = V_{B1} + V_{Diff.}$	Unijunction transistor - circuit diagram of pulse generator
18.7	Thyristor - structure, electrodes and symbol - different types - working principle - application	Thyristor - determination of holding current, holding voltage with help of characteristic curve - dynamic resistance $r = \frac{\Delta V_F}{\Delta I_F}$	Thyristor circuit diagram of - controllable rectifier circuits
19 19.1	Principle of picture transmission TV picture - picture conversion to video signal - definition of line scanning	TV picture - calculation of horizontal frequency $f = \frac{1}{T} = \frac{1}{64\ \mu s}$	Thyristor continuous circuit diagram of - voltage regulator with thyristor

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20 20.1	Principle of b/w TV receiver Types of TV receiver - all tube receiver - transistorised - hybrid receiver	Wave progation - type of wave -ground wave in-ospheric wave - used wave for LW,MW,SW, USW,	B/W TV receiver - block diagram, representation of: Tuner - VHF, UHF, IF stage video detector video amplifier sound IF amplifier sound detector sound output stage
20.2	Introduction of b/w TV receiver - explanation of block diagram Tuner for VHF and UHF Picture IF amplifier Video amplifier picture tube sound IF amplifier sound detector sound output stage pulse separation vertical deflection horizontal deflection high voltage stage	Television channels preparation of table: - range: I (USW), III (VHF), IV (UHF), V (UHF) - used channel for range I - V - used frequency for range I-V	Block diagram of b/w TV receiver continuous - pulse separator vertical frequency generation vertical output stage and deflection horizontal frequency generation horizontal output stage and deflection high voltage stage picture tube

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
20.3	Intermediate frequency stage transistor/ valves - Purpose of IF-stage - frequency response curve - pass range, band-width - picture carrier IF - sound carrier IF - explanation of circuit diagram	Oscillator frequency - $fo = \frac{IF\ (38,9\ MHZ) + f_{PC}}{(Ch.5 - 175,25\ MHZ)}$ - $fo = \frac{IF\ (33,4\ MHZ) + f_{SC}}{(Ch.7 - 194,75\ MHZ)}$	Intermediate frequency stage circuit diagram of: - IF amplifier stage - transistor, - representation of AGC
20.4	Video detector - basic circuit diagram - working principle of detector - input output signal	R E V I E W	Video stage circuit diagram of: - video detector stage
20.5	Video amplifier transistor/valve - basic circuit diagram - working principle - contrast	R E V I E W	Video stage - video amplifier with 1 transistor
20.6 IV Start	Video amplifier transistor/valve coupling out of sound, signal for amplitude separator - automatic gain control	Automatic gain control - calculation of time constant for automatic gain control RC filter	Video stage - video amplifier with 2 transistors

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
20.7	<u>Sound section</u> - principle of intercarrier technique - circuit diagram - working principle of IF amplifier, ratio detector and AF amplifier	<u>Sound section</u> - determination of intercarrier frequency (sound IF 5.5 Mhz)	<u>Video stage</u> - video amplifier with valve
20.8	<u>Pulse section transistor/valve</u> - meaning of pulse clipping - meaning of synchronizing pulse separation	<u>Pulse separation</u> calculation of: - RC integration circuit for horizontal synchronising pulse $\tau = R \times C$	<u>Pulse section</u> circuit diagram of: - amplitude separator with transistor
20.9	<u>Amplitude separator transistor/valve</u> - basic circuit diagram and working of amplitude separator stage	<u>Pulse separator</u> - RC differentiating circuit for horizontal synchronising pulse $\tau = R \times C$	<u>Pulse section</u> circuit diagram of: - amplitude separator with valve
20.10	<u>Vertical deflection transistor/valve</u> - generation of vertical deflection frequency - synchronisation of vertical pulse generator - adjustment of vertical hold	<u>Generator of vertical frequency</u> - calculation of astable multivibrator for vertical generator $\tau_{puls} = 0{,}69 \times R \times C$ $\tau_{break} = 0{,}69 \times R \times C$	<u>Vertical deflection</u> circuit diagram of: - blocking oscillator

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20.11	Vertical deflection transistor/valve - working principle of vertical amplifier stage - adjustment of height- and linearity control - output stage and connection to deflection coils	Generation of vertical frequency - $T = \tau_P + \tau_b$ - $f = \frac{1}{T}$	Vertical deflection circuit diagram of - vertical output stage
20.12	Horizontal deflection transistor/valve - generation of horizontal frequency - horizontal synchronisation, generation and working principle of control voltage for AFC.	Generation of horizontal frequency - calculation of astable multivibrator for time base generator $\tau_{puls} = 0{,}69 \times R \times C$ $\tau_{break} = 0{,}69 \times R \times C$	Horizontal deflection - circuit diagram of horizontal frequency generator (transistorized astable multivibrator)
20.13	Horizontal deflection transistor/valve - working principle of horizontal output stage - need and operation of booster capacitor and line fly back - generation of high voltage and connection to picture tube - block diagram of complete horizontal stage and connection to deflection coils.	Generation of horizontal frequency - $T = \tau_p + \tau_b$ - $f = \frac{1}{T}$	Horizontal deflection - block diagram of complete horizontal stage (horizontal generator output stage and high voltage stage)

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING
20.14	Picture tube - structure of PT - function of PT - base diagram and anode terminal - precaution of high voltage	Television standard (CCIR) preparation of table - type of modulation for picture and sound carrier - transmission for picture carrier - intermediate frequency for picture and sound carrier - channel band-width VHF, UHF - number of lines	TV b/w picture tube - structure of picture tube representation of beam system
20.15	TV power supply - circuit diagram and working principle of transistorized power supply	Power supply Transistorized power supply calculation of: - dynamic internal resistance $r = \frac{\Delta V_{out}}{\Delta I_{out}}$	Power supply - transistorized power supply
20.16	TV power supply - circuit diagram and working principle of power supply with valves	Power supply stability factor $S_t = \frac{\Delta V_{in} \times V_{out}}{\Delta V_{out} \times V_{in}}$	Power supply - power supply with thyristor for TV receiver

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20.17	TV circuit diagram - recognize of different circuit stages - signal tracing in a complete circuit diagram - identify of voltage values	REVIEW	Power supply - power supply for valves type TV set
21 21.1	Colour TV Introduction of colour TV - comparison of signals between monochrome - and colour TV - luminance signal - colour difference signals	Colour signals - video signal $Y = 0.3\ V_R + 0.59\ V_G + 0.11 V_B$ - determination of $V_R - V_Y$ $V_B - V_Y$	Circuit details of colour TV - chrominance signal amplifier
21.2	Mixing of colours - additive colour mixing - colour diagram, primary colour - complementary colours - reduction of colour difference sign.	Colour signals continuous calculation of reduced colour difference signals U and V $- U = 0.493\ (B - Y)$ $- V = 0.877\ (R - Y)$	Circuit detail of colour TV - PAL delay time demodulator