6th FOOD ANALYST EXAMINATION (FAE-2019)
&
3rd JUNIOR ANALYST EXAMINATION (JAE-2019)

EXAMINATION PLAN – THEORY PAPER

PAPER - I (Single Session - 3 hours – 2:00 PM to 5:00 PM)			
S.No	**Topics**	**Weightage, %**	**Questions, No.**
1	Food Laws and Standards of India and International Food Laws	20	40
2	Planning Organization and setting up of Food Analysis Laboratory including NABL / ISO / IEC-17025: 2017 and laboratory safety	10	20
3	Principles of Food Preservation, Processing and Packaging.	05	10
4	Principles and Basics of Human Nutrition	05	10
5	Food Chemistry	20	40
6	Food Microbiology and Food Hygiene	20	40
7	Physical, Chemical and Instrumental analysis	20	40
	TOTAL	**100**	**200**

- All questions will be of Multiple Choice Questions (MCQ) type.
- ***Four marks*** will be awarded for ***each correct answer*** and ***one mark will be deducted*** for ***each incorrect answer***.
- The FAE/JAE candidates should secure a minimum of 40% to be declared as passing the theory paper.
- The candidates of FAE-2019 who pass and qualify the theory paper (*i.e.*, Paper-I) only will be eligible to appear for Practical (*i.e.*, Paper-II). Dates, venue and syllabus of **Paper-II** will be intimated separately.
- The candidates of JAE-2019 who pass and qualify the theory paper (*i.e.*, Paper-I) only will be awarded certificate as qualified Junior Analyst. JAE qualified candidates will be allowed to appear for Paper-II for FAE, onlyafter obtaining the requisite experience of 3 years. This opportunity is available to qualified JAE only once.
- Syllabus for Paper I is provided here.

SYLLABUS FOR PAPER-I

1. Food Laws and Standards of India and International Food Laws:

I. Food Safety and Standards Act of India, 2006: Provision, definitions and different sections of the Act and implementation.

II. FSS Rules and Regulations (2011) as amended from time to time -

a) Licensing and registration: Central license, State license, Registration, Responsibilities of the FBO, Role of Designated officer, Food Safety Officer and Food Analyst.

b) Standards of Quality and Safety of Food & Food Products laid down in the FSS Regulations, 2011. The different food categories in the Act. The relevance of the standards (Vertical and Horizontal) quality and safety parameters to particular foods including current food safety issues.

c) Regulations of food additive: What is an additive, various groups of additives and their technological functions, INS number: food colors, antioxidants, sweeteners, preservatives, processing aids. Food processing aids. The Indian Food Code and using the hierarchy to understand the category wise approval of Food additives.

d) Packaging and labelling rules and regulations: List of ingredients, nutritional information, special label declarations, claims-Health, nutrition, nutrient led claims, use of words and phrases on label

e) Regulations for Contaminants, Toxins and Residues and restriction of sales.

f) Food Safety and Standards (Food or Health Supplements, Nutraceuticals, Foods for Special Dietary Uses, Foods for Special Medical Purpose, Functional Foods and Novel Food) Regulations, 2016Food Safety and Standards (Food Recall Procedure) Regulation, 2017Food Safety and Standards (Import) Regulation, 2017

g) Food Safety and Standards (Organic Food) Regulation, 2017.

Food Safety and Standards (Fortification of Foods) Regulations, 2018

Food Safety and Standards (Alcoholic Beverages) Regulations, 2018

h) Laboratory sampling and analysis: The role of Referral labs, FSSA notified laboratories and State Food Laboratories and functions. Receiving legal samples, sample custody and sample custodian. Storage of sample. Required documentation and registration, storage of the sample Analyses as per FSS Rules and Regulations (2011).

III. Other National Laws and Standards

a) Agricultural Produce Act, 1937 (Grading and Marketing)
b) Export (Quality Control & Inspection), Act, 1963 and Rules
c) Bureau of Indian Standards relevant to Food Safety (Water, Infant Formula etc0
d) Legal Metrology Act

IV. International Food Control Systems/ Laws, Regulations and Standards/ Guidelines with regard to Food Safety:

a) CODEX Alimentarius Commission: History, Members, Standard setting and Advisory mechanisms: JECFA, JEMRA, JMPR

b) WTO agreements: SPS/TBT

c) Role of OIE, IPPC.

2. Planning Organization and setting up of Food Analysis Laboratory including NABL / ISO / IEC-17025: 2017 and laboratory safety.

I. Understand the requirements for setting up a laboratory for the legal defensibility of analytical data. The ideal structure design, environment, layout for chemical and microbiological testing, Air handlingetc

II. What is accreditation, Different accreditation bodies (NABL, APLAC, ILAC). Requirements for ISO/IEC 17025:2017, documentation, pre-requisites for accreditation, management requirements, technical requirements, measurement of traceability

III. Laboratory safety: Personnel and laboratory hygiene, emergency planning, General hazards in a food laboratory, safety equipment,storage of chemicals, acids, flammables etc, handling compressed gases, centrifuge, chemical and biological spills and waste disposal.

3. Principles of Food Preservation, Processing and Packaging.

I. Food Processing Operations: Manufacturing processes: batch, Semi-batch and continuous Cleaning of raw materials: cleaning methods and contaminations, Size reduction and screening of solids: equipment, modes of operation. Disintegration of materials: slicing, dicing, shredding, pulping. Mixing and emulsification. Filtration and membrane separation: principles, design features and general applications Centrifugation: principles and applications. Solid-liquid extraction and expression. Sorting and grading of foods: weight, size, shape, buoyancy, photometry sorting

II. Food Preservation by

a) Heat: Principles of Heat Transfer, Blanching, Pasteurization, Heat Sterilization, thermal extrusion, cooking

b) Water Removal: Forms of Water in Foods, Sorption of Water in Foods, Water Activity, Drying and Evaporation Technology

c) Temperature Reduction: Chilling, Freezing

d) Radiation: Ionizing Radiation, Microwave

e) By use chemicals: Class-I and Class-II preservatives, smoke other Chemical Additives

f) New non-thermal methods: high hydrostatic pressure, modified atmosphere, high-intensity pulsed electric fields, intense pulsed light, oscillating magnetic fields), hurdle technology,ultrasonic and ohmic heating etc.

III. Food Packaging:

a) Effect of Environment on Food Stability: Light, Oxygen, Water, Temperature, Sensitivity to Mechanical Damage and attack by biological agents

b) Different packaging materials used for food packaging and their properties – including barrier properties, strength properties, optical properties: Glass, Metals, Paper, Plastics, Biodegradable and Edible Films and Coatings, aseptic packaging and Combinations.
c) Selection of packaging material and design for various food commodities including fresh produce (fruits and vegetables), milk and milk products (dairy), cereal, pulses, oil, meat, fish, poultry, water and processed foods.
d) Evaluation of quality and safety of packaging materials – different testing procedures
e) Functions of Packaging: Protective Packaging and active packaging smart and intelligent packaging.
f) Newer packaging technologies- CAP/MAP packaging, aseptic processing and packaging, irradiated packaging, retort pouch, microwaveable packaging.

4. Principles and Basics of Human Nutrition

a) Water: sources, body's needs, physiologic function
b) Body composition, Energy metabolism and nutritional requirements of the body. Recommended daily allowance (RDA), Basic metabolic rate (BMR)
c) Carbohydrates: Digestion of Simple and complex carbohydrates, dietaryfiber, absorption of glucose, carbohydrate metabolism, Diabetes.
d) Lipids: Triglycerides, digestion, absorption, and transport, essential fatty acids (EFA), metabolism of fats. Cholesterol role in cardiovascular disease
e) Protein: Essential and nonessential amino acids, digestion and absorption of protein, protein metabolism, protein quality (biological value, protein efficiency ratio, net protein utilization intake and role in the body.
f) Vitamins: Deficiency diseases toxicity, sources, and function.
g) Minerals: Major and minor minerals nutritional significance and physiological role of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper, selenium. (their dietary sources and deficiencies).
h) Macronutrient deficiency diseases, Overnutrition, Undernutrition, Malnutrition (Kwashiorkor & Marasmus)
i) Food allergens, Allergenicity and Inborn errors of metabolism
j) Diet and Health: Diabetes, cancer, stroke, hypertension, heart health

5. Food Chemistry

I. *Water*: Water as a nutrient, function, sources, requirement, structure, water balance – effect Moisture in food: Hydrogen bonding, cohesion and adhesion properties, specific heat, osmosis colloidal properties of foods. Acid – base balance, pH, Hydrogen ion concentration, Buffers and Henderson Hasselbach equation.
II. *Carbohydrates*: Nomenclature and different methods of classification, structure and chemical properties of monosaccharide, disaccharides and polysaccharides and complex carbohydrates; amino sugars, proteoglycans and glycoproteins. Reducing

and non- reducing sugars, Optical and stereoisomerism.Different Color reactions of carbohydrate. Changes in carbohydrates during processing. Maillard reaction

III. *Proteins and amino acids*: Classification of amino acids based on structure; aromatic, aliphatic, acidic, basic, sulfur containing, branched chain, essential and non-essential amino acids. Globular& Fibrous protein, Hierarchy in structure (primary, secondary, tertiary), isoelectric point, Protein denaturation, digestibility. Color reactions of proteins and amino acids. Amino acid analysis, protein digestibility corrected amino acid score (PDCAAS). Rheological properties of protein- solubility, viscosity, gelling, surfactants/

IV. *Lipids*: Classification, nomenclature, structure, properties and functions of fatty acids, fats, phospholipids, sphingolipids, cerebrosides, steroids, cholesterol, plant sterols, bile acids, prostaglandins, lipoamino acids, lipoproteins, proteolipids, lipopolysaccharides. Reactions of lipids, oxidative and hydrolytic rancidity. Different types of fats, uses in food processing, food emulsions, fat replacers, esterified fats. Changes during food processing. Protein lipid interaction, Lipid Carbohydrate interaction, Lipid-Lipid interaction. Fatty acid analysis and composition

V. *Vitamins*: Water- and fat-soluble vitamins: Classification, structure, physiology biochemical functions as coenzyme. Effect of various processing treatments and fortification of foods.

VI. *Food Additives*: Structure, Chemistry, Function and application of Preservatives, Emulsifying and Stabilizing agents, Sweeteners, buffering agents, bleaching, maturing agents and starch modifiers, Food colors, flavors, anti-caking agent, Antioxidants etc. The nature, properties and functions and mode of action. Safety assessment of Food additives: No-observed Effect Level (NOEL Acceptable daily intake (ADI), Dietary exposure,) in chronic toxicity studies

VII. *Antinutritional Factors:* Protease Inhibitors, Haemagglutinins (Lectins), Glucosinolates, Cyanogens, Saponins, Gossypol, Lathyrogens, Antivitamins, Antiminerals. Bitter substances, tannins and their removal from foods.

VIII. *Food Enzymes*: Properties, classification, enzyme units, enzyme kinetics, MichaelisMenten equation, regulatory enzymes, isoenzymes, enzyme inhibition and kinetics of enzyme inhibition, elements of bioenergetics. Role in foods: Beta-galactosidase, alpha galactosidase, proteases (papain, bromelain), lipases, oxidases etc,Polyphenol oxidase, enzymatic and non-enzymatic browning.

IX. *Nucleic Acids*: DNA: Physical and chemical properties (renaturation anddenaturation). Structure of nitrogenous bases, nucleosides, nucleotides, DNA Doublehelix -Watson & Crick model of DNA,RNA Classes; mRNA, tRNA and rRNA.

X. *Nutraceuticals and Functional Foods*: Definition and function of Nutraceuticals, Functional Foods, Food Supplements, Dietary supplements prebiotics and probiotics,

Medical foods and foods for special purposes. examples Phenyl alanine free diet for Phenylketonuria patients, Lactose free for Lactose intolerant.

XI. *Plant pigments:* Structure and function of Chlorophylls, lycopene, betalaine, curcuminoids, annatto, Carotenoids, anthocyanins, flavonoids, melanin, tannins, quinones, and xanthone. And roles in food industry.

XII. *Radioisotopes*: Origin and properties of radioactivity. Detection and measurement of radioactivity, Geiger-Muller Counter, and types of scintillation counters and counting, Scintillation counting of γ ray, Concept of dpm and cpm.Applications of irradiation in food preservation/safety. Safety rules for handling radioactive materials

XIII. *Genetically modified organism (GMOs):* What are GMOs? Which are the major GMOs in food and what are the traits that have been engineered. How to detect and quantify GMOs.

XIV. *Food contaminant and adulterants*: Major Classes of Pesticide and their residues. Heavy metals. Antibiotic & hormone residues, Veterinary drug residue, other new contaminants and toxins (For example: Cyclopiazonic acid in Buckwheat flour) , radioactive nuclides, mycotoxins (Aflatoxin, Ochratoxin, Patulin, DON, Ochratoxins, Sterigmatocystin, Fumonisins, Zearalenone). Common Adulterants: Lead chromate, mineral oil, urea, SDS, starch, blotting paper, metanil yellow, Rhodamineargemone, khesari dal, brick power etc,)

6. Food Microbiology& Food Hygiene

I. *Introduction to Food microbiology*: Classification and nomenclature of microorganisms. Morphology and Structure of Microorganisms in Foods (Yeasts and Molds, Bacterial Cells Viruses). Important genera of Mold, yeast, bacteria (gram-negative aerobesandfacultative anaerobes, gram-positive cocci, endospore-forming rods, non-sporulating), bacterial groups (lactic acid, acetic acid, butyric acid etc), thermophilic, proteolytic, saccharomyticetc, coliforms, faecal coliforms, enteric pathogens. Emerging microbes.

II. *Sources of microorganisms in food chain* (raw materials, water, air, equipment etc) and microbiological quality of foods

III. *Microbial Growth Characteristics*: Reproduction and growth (fission, generation time optimum growth, growth curve etc). Microbial growth in foods: Intrinsic (pH, Moisture Content, Oxidation–Reduction Potential, Nutrient Content, Antimicrobial Constituents) and Extrinsic Parameters (Temperature of Storage, Relative Humidity of Environment, Presence and Concentration of Gases in the Environment).

IV. *Thermal Destruction of Microorganisms*, Thermal Death Time, *D* Value ,*z*Value , *F* Value , Thermal Death Time Curve, 12 D Concept.

V. *Microbial food spoilage and Food borne diseases*, food pathogens*Aeromonashydrophila, Bacillus cereus and other Bacillus Species, Brucella, Campylobacter, Clostridium botulinum, Clostridium perfringens,*

Enterobactersakazakii, Escherichia coli, Listeria monocytogenes, Salmonella, Shigella, Staphylococcus aureus, Vibrio, Yersinia enterocolitica, Fungi, virus etc

VI. Methods for the Microbiological Examination of Foods: Sampling Two-class and three-class sampling plan. Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria. Indicator Organisms: Direct Examination, Enumeration Methods, Plate Counts, Most Probable Number Counts, biochemical test, Rapid Methods for Detection of Specific Organisms and Toxins, Immunological Methods, DNA/RNA Methodology

VII. *HACCP and Food Safety Management Systems*: ISO 22000: Importance of implementing a HACCP system and how it can be applied to various products. Prerequisite Programs, HACCP Principles, Some Limitations of HACCP Food Safety Objective (FSO). Food Safety Audits: management review, audit certification and its importance. Good Manufacturing Practices (GMP) Good Hygienic Practices (GHP), Food Safety Plan, Food Safety Management Risk Analysis. Traceability, food product recall. Sanitation

7. Physical, Chemical and Instrumental analysis

I. *Sampling and sample preparation*: Definition, types of sample, sampling plan, subsampling, designing a sampling plan, concept of sample size and representative. Sample preparations – particle size, homogeneity, dissolution technology anddecomposition, storage of samples.Solid Phase Extraction- Introduction, sorbents, matrix solid phase dispersion and applications.

II. *Statistics and statistical terms:* Systematic and random errors. Mean distribution. Confidence interval. Confidence limits and confidence level. Outliers. Definition and calculation of: Average, Mean, Standard deviation, Relative standard deviation, Coefficient of variation, Confidence limits of a measurement, Statistical Tests, Linear correlation and regression curve fitting, fitting of linear equations. Choosing and using statistical tests, Analysis of Variance (ANOVA),

III. *Basic principles of Classical Methods of food analysis*: Law of mass action, Le chateliers principle, stoichiometry, volumetric and gravimetric analysis. Preparation of standards, working standards and solutions of known concentration (percent, molar, molal, normal, ppm and ppb) and their dilution. Proximate analysis, physical methods for extraneous matter analysis

IV. *Classical analytical techniques: Gravimetry, Titrimetry, Refractometry and Polarimetry*: Principle, Instrumentation and applications of each technique in food analysis

V. *UV-Visible and FluorescenceSpectrometry*: Electromagnetic spectrum, Beer and Lambert's Law, Absorbance, Transmittance, Molar absorptivity (Molar Extinction coefficient), E 1%, λMax. Components and functioning of an UV-vis spectrophotomer: Single beam and double beam. Components of a UV-VIS spectrum. Calibration curve andapplications in food analysis.

VI. *Raman spectroscopy*: Principle Theory Instrumentation, techniques and Applications of Raman spectroscopy in food analysis

VII. *Chromatographic techniques*: Fundamentals of chromatographic separations and their classification. The plate theory. Capacity factor and resolution factor. Chromatographic efficiency. Van Deemter's equation. Partition coefficient etc. Principles and applications of paper (Ascending, Descending, Radial, Two dimensional) Partition, Thin layer chromatography, HPTLC, size exclusion and ion exchange chromatography. Applications in food analysis

VIII. *High Performance Liquid Chromatography (HPLC):* Basics of liquid chromatography, HPLC columns and Stationary phases (solid, liquid) – Bonded phase supports, mobile phases, isocratic and gradient elution, Detectors: UV absorption, Fluorescence detector, RI detectors, electrochemical detectors, Photo diode array, Evaporative light scattering detector, PHRED anatomy of a chromatograms. Modes of separation Normal and Reverse Phase. Sample Preparation Techniques, Applications in quantitative food analysis of aflatoxins, vitamins, sugars, sweeteners, preservatives etc.

IX. *Gas chromatography:* Basics of Gas chromatography, Mobile phase and criteria for its selection – Sample introduction techniques – Stationaryphases– Supports for liquid stationary phases, Selection ofcolumns. Detectors FID, TCD, FPB, ECD, TID. Temperature programming in GC – Derivatizationand sample preparation in GC –Fatty acid profile and quantitative analysis of fatty acids in fats and oils.

X. *Mass Spectrometry*: Basics of mass spectrometry, Components of a mass spectrometer, Ionization and ion sources: Electrospray, chemical, Fast Atom Bombardment, MALDI, Atmospheric Pressure Chemical ionization and other ionization methods. Mass analyzers: Quadrupole Analyzers, Ion Trap Analyzers, Electrostatic Trap or 'Orbitrap', Time-of-Flight Analyzers, Hybrid Instruments. Detectors: Photographic plate, Faraday cup Electron multipliers. Data acquisition, Data conversion, Data reduction andLibrary search. Tandem Mass Spectrometry and its applications.

XI. *Hyphenated Techniques*: Mass Spectrometry and Chromatography Coupling. GC-MS/MS, LC-MS/MS, Capillary electrophoresis-MS, Isotopic Ratio mass spectrometry. Analytical Information: Mass Spectrometry Spectral Collections, high resolution, quantitative data, fragmentation and spectrum interpretation.

XII. *Atomic absorption Spectroscopy, Atomic emission spectroscopy, ICP-MS*: Principles-Atomization process, Atomic line widths and radiation sources for AAS, temperature gradients, cells detectors, interferences, Background correction methods and modifications in instrumentations, Atomic EmissionSpectroscopy: Atomic spectra, Population distribution with temperature, Sources, spark laser microprobe for atomic emission, Spectrometers, Merits, demerits, and applications. Basic principles and instrumentation of ICP-MS; data acquisition and interpretation; applications of ICP-MS for analysis of metallic contaminants in food. Sample preparation, microwave digestion.

XIII. *Biological Techniques (DNA/protein based)*: Fundamental principles and instrumentation of the systems; measurement techniques and result interpretations of Polymerase Chain Reaction (PCR), Real-time Polymerase Chain Reaction (PCR) technique; Enzyme Linked Immunosorbent Assay (ELISA); Radioimmunoassay (RIA). Use of PCR for detection of genetically-modified organisms (GMO);meat and fish speciation and other applications in analysis of food adulteration.

XIV. *Measurements of Rheological properties*: Instrumental Measurement of Texture of Foods, Visco Analysis, viscometer, texture analyseretc.

XV. *Quality assurance and Quality control*: Introduction to quality control in analytical chemistry. Terminology in analytical measurements: True value, Measured value, Accuracy, Precision, Uncertainty, Random errors. Sample traceability, Internal quality control, Certified reference materials. Spiked reference samples. Recovery studies, Method validation/verification (LOD, LOQ, specificity, selectivity, linearity, range, robustness, repeatability, reproducibility. External and internal standards, Control chart. Proficiency testing, z scores

Suggested Reading

1. Ahvenainen, R. (Ed.) 2003 Novel Food Packaging Techniques, CRC Press.
2. AOAC (1997). Official Methods of analysis. 18th edition. Association of official Analytical Chemists.
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4. Beaton, G.H. and Bengoa, J.M. (Eds) (2000): Textbook of Human Nutrition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
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6. Bender A E, Dictionary of Nutrition and Food Technology, 5th Edn, Butterworth Scientific, London, 1990
7. Bryan, F.L. (2000): Hazard Analysis Critical Control Point Evaluations A Guide to Identifying Hazards and Assessing Risks Associated with Food Preparation and Storage. World Health Organisation, Geneva.
8. Cappuccino JG, Sharman N(2002). Lab Manual of Microbiology. Pearson Education Publishing Co.
9. Christian (2004) Analytical Chemistry (John Wiley & Sons Inc.) 6 th edition.
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19. Food Chemicals Codex, 6th edition 2008
20. Food Safety and Standards Act (2006)
21. Food Safety and Standards Rules and Regulations (2011), as amended by Amendment Rules (2017)
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31. Harrigan M E and McCance M E, Laboratory Methods in Food and Dairy Microbiology, Revised, Academic Press Inc, London, 1982
32. Harris (2010) Quantitative Chemical Analysis (Freeman, New York), 8th Edition.
33. ICMR Nutrient Requirements and Recommended Dietary Allowances for Indians
34. Jain, J.L., Fundamentals of Biochemistry- S. Chand &Company Ltd, Ram New Delhi
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37. Keer, J T and Birch, L (2008) Essentials of Nucleic Acid Analysis, a Robust Approach RSC Publishing,
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71. Wrolstad, R. Handbook of Food Analytical Chemistry New Jersey, John Wiley Sons 2005
72. Yousef AL (2003). Food Microbiology. A Laboratory Manual. Wiley Inter science New Jersey.
73. Relevant documents available at **http://www.fao.org/fao-who-codexalimentarius/en/**