Flicker — Temporal Light Modulation

Invisible flicker, comfort, and neural excitability

Definition

Variation of light output over time; described by modulation %, frequency, and waveform. Can be imperceptible yet biologically active.

Recommended Ranges

|  |  |
| --- | --- |
| Optimal | Percent modulation ≤5% across occupied dimming range; avoid low fundamentals. |
| Caution | 5–20% or fundamentals <100 Hz; evaluate stroboscopic risk. |

Biological Effects

Hormones (Endocrine)

Discomfort/stress from flicker → ↑ ACTH → cortisol↑; chronic exposure may destabilize HPA in sensitive individuals.

Skin (Photobiology & Peripheral Clocks)

No direct photochemical effect at classroom intensities.

Nervous System (ipRGC → SCN → CNS)

Low-frequency components can entrain abnormal cortical rhythms; trigger migraines/photosensitive seizures in vulnerable populations.

Raises saccadic suppression demand → eye strain, headaches, reduced reading endurance.

Biochemical Pathways (Mechanistic Detail)

Repetitive drive → glutamatergic overactivation in visual cortex; excitotoxic susceptibility increases.

Arousal circuits: locus coeruleus NE↑; HPA axis activation (CRH→ACTH→cortisol).

Classroom Recommendations

Specify drivers compliant with IEEE 1789; check flicker at multiple dim levels.

Test under mains variation; avoid deep PWM at low frequencies.

Quick Checklist

Percent modulation and/or short-range index documented.

No visible stroboscopic artifacts with moving objects.

References

IEEE 1789 — Recommended practice for LED modulation (flicker).

Clinical literature on photosensitive epilepsy/migraine triggers.